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ORIGINAL ARTICLES

EVOLUTION, CONSTRUCTION AND MANIPULATION OF THE PIN AND TUBE APPLIANCE*

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TO Dr. Edward H. Angle is due the credit of this appliance in its present form. It was he who first conceived and described its use in the treatment of malocclusion of the teeth. The first article by him on this topic was under the title "Bone Growing" and was published in the *Dental Cosmos* for March, 1910.

This appliance is shown in Fig. 1 and was used as a working retainer in cases where it was found desirable to move the roots of the anterior teeth forward and at the same time prevent the crowns of the teeth from moving. In this appliance you will observe that the maxillary incisors are fitted with bands having small round tubes soldered on their labial surfaces parallel to the long axes of the teeth. It was necessary that these tubes be parallel with each other to enable the spurs soldered to the arch wire to enter them. You will also observe that the middle section of these tubes was cut away on the labial surface. The reason for this will appear later. The arch wire .029 inch in diameter was soldered to screw sections that telescoped into round buccal tubes on the molar bands. To place the appliance the screw sections were first inserted into these buccal tubes and the arch wire sprung incisally so that the spurs could enter their respective tubes on the incisor bands. To alter this appliance so as to exert force to carry the incisor roots forward the appliance was sprung incisally just sufficient so that the ends of the spurs were free of the gingival portion of the tube. With a suitable instrument (a small hatchet excavator) the spurs were bent labially the desired extent and then carefully worked back into the gingival portion of the tube

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and the appliance carried to place. The cutaway labial portion of the tubes permitted the bending of the spurs as described above without entirely removing them from the tubes.

This was a very ingenious arrangement but in practice it was found that these delicate spurs were very liable to be bent back almost to their former shape in working them back into the gingival portion of the tubes, for it must be remembered that the appliance was not removed from the mouth and therefore could not be tempered by heat.

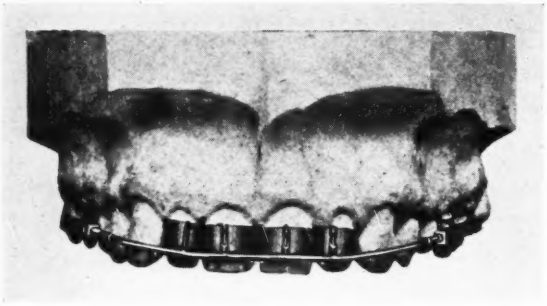


Fig. 1.

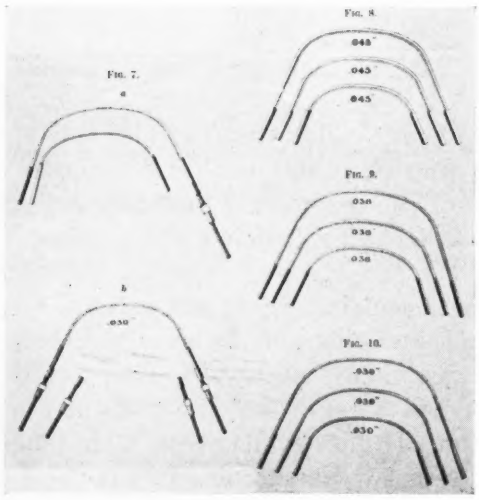


Fig. 2.

In the *Dental Cosmos* for August, 1912, under the title "Evolution of Orthodontia—Recent Developments" appeared a second article by Dr. Edward H. Angle. In this article we find some marked improvements.

Fig. 2 shows the three-piece arch.

Fig. 3 shows the pins both actual size and magnified and also the tube. These tubes had a bore of .022″ and the pins were .022″ in diameter.

Fig. 4 shows the band material with tubes attached.

Fig. 5 shows the pin holder and pin.

Fig. 6 shows an ingenious spring arrangement to be used to rotate a tooth.

This appliance consisted of two screw sections which had square sockets in their anterior end to receive the square ends of the middle section. This

device enabled the proper placing of the middle section after the pins were soldered in place. When the middle section was placed in proper position the screw sections were brought forward so that their square sockets telescoped over the square ends of the middle section and the nuts were turned up. This united the three pieces to make a continuous arch wire, as shown in Figs. 7 and 7-*A*. Obviously this middle section could be removed from the teeth, reshaped, heat treated and reapplied. This was found to be a great advantage.

All the parts of this appliance were beautifully made of precious metal, and while they were extremely delicate they proved to be wonderfully efficient in the treatment of certain types of malocclusion.

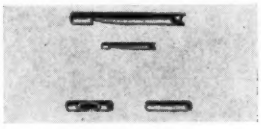


Fig. 3.

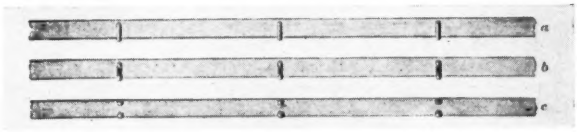


Fig. 4.

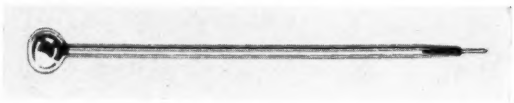


Fig. 5.

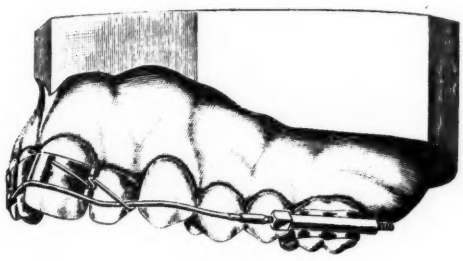


Fig. 6.

In the *Dental Cosmos* for January, 1913, under the title, "Further Steps in the Progress of Orthodontia" appeared a third article by Dr. Edward H. Angle. Careful perusal of this article shows practically no change in the appliance, except that the springs for rotating teeth are not shown. There are shown some marked improvements in the technic of constructing the appliance. In Fig. 8 is shown a unique method of attaching the correct amount of solder to the pin.

In Fig. 9 is shown an accurate method of soldering the tube to the band.

In Fig. 10 is shown an ingenious but complicated device for soldering the pins in their proper positions on the middle section of the arch wire. All this tends to prove that the profession experienced great difficulty in properly

constructing this appliance even when supplied with parts by the manufacturer.

This is not surprising when we recall that the labial tubes had a bore of exactly the same size as the diameter of the pins that were supplied. This accuracy of fit proved to have another disadvantage. Namely, it allowed very little physiologic tooth movement of the teeth attached to this appliance when under stress. Owing to the design of the appliance the rotation of teeth became somewhat uncertain. This could be accomplished in one of three ways. First, by bending the arch wire so that it exerted pressure

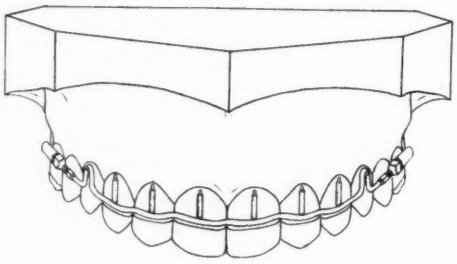


Fig. 7.

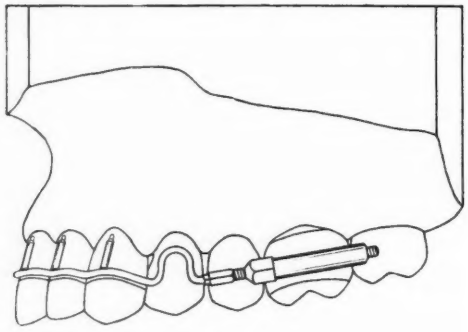
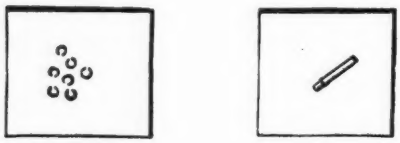


Fig. 7-*A*.



a *b*

Fig. 8.

on the tooth in the opposite direction from that exerted by the pin. Second, by placing a wedge of rubber between the arch wire and the tooth. Both of these methods were satisfactory when used on the maxillary centrals, owing to their width, but on the other anterior teeth and on the canines and premolars it did not so prove. The third method was to place the tube off center on the band which proved successful except in those cases where the dental arch had to be lengthened and then it was found that the teeth would usually rotate before they were carried forward to their proper position. This necessitated the removal of the band and resoldering the tube. Another weakness in this appliance was the three-piece arch. It was found that there was play at the points where the middle section and the two end

sections joined. This was particularly noticeable in cases where it was necessary to carry the molars buccally.

The writer began the use of these appliances in 1910 and in a short time it occurred to him that the same principle of attachment used on the anterior teeth could be employed on the molar teeth. Since 1911 the three piece arch has been superseded by a continuous one-piece arch which will now be described, along with other modifications that have developed with its use.

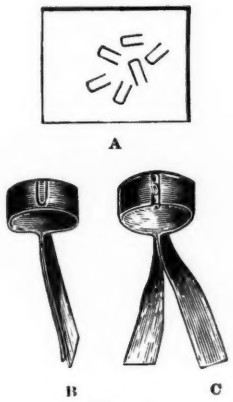


Fig. 9.

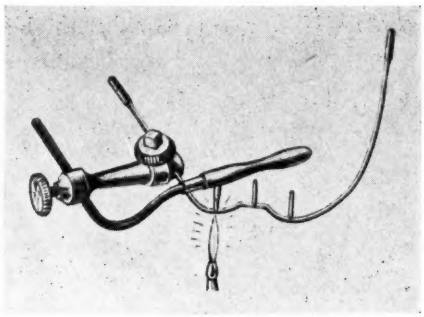


Fig. 10.

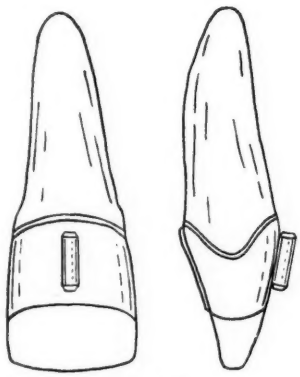


Fig. 11.

Fig. 12.

On the buccal surface of each molar band is soldered a tube either round, half-round or elliptical. This tube should be placed well forward and close to the occlusal edge of the band when it is for a maxillary molar. If for a mandibular molar the tubes should be well forward and close to the gingival edge of the band, thus allowing room for the arch wire to pass over the occlusal end of the tube and not interfere with the occluding teeth in the opposite jaw. A snug-fitting post of the same shape as the lumen of the tube will not rotate in it except where the round tube is used. It was found that these tubes could be .10″ in length and that this was sufficient if the

post accurately fitted the tube. Obviously, the tube must be constructed of stable material and should have sufficient thickness to its walls so that it cannot be stretched when placing and removing the post.

All teeth to be moved are fitted with bands of sufficient width so that the arch wire does not lie over exposed enamel (Fig. 11). It has also been found advisable to carry the band well up to the gingiva on the labial side. This necessitates that the bands be cut away on the approximal sides so as to conform to the gum festoon.

If these bands are properly fitted they can be placed on the incisors so that the incisal edge of the band is to the gingival of the point of contact. It

Fig. 13.

Fig. 14.

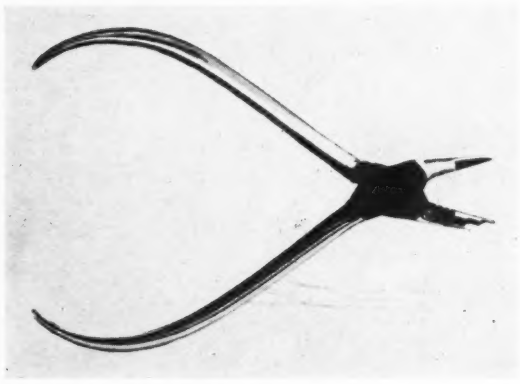


Fig. 15.

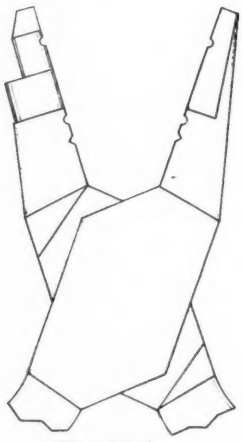


Fig. 15-A.

is important that this should not be overlooked where so many bands are used; otherwise spaces will exist when the bands are removed.

For a number of years round labial tubes as described by Dr. Angle were used but in later years small half-round tubes, first used by Dr. C. A. Hawley, have proved far more satisfactory and have entirely superseded the round ones. These tubes are .10″ in length and have a lumen .021″ × .040″.

These labial tubes are soldered so that the ends are at equal distance from each edge of the band, and line parallel with the axes of the teeth. It is not necessary that these tubes be parallel. In fact, in many cases they are not.

Before cementing these bands on the teeth the tubes should be filled with wax to prevent the cement from entering. Care should be used that wax does not get on the tooth side of the band because the cement will not adhere

to wax. After the bands are securely cemented the patient should be discharged for at least twenty-four hours to allow the cement to thoroughly set, before any attempt is made to clean out the tubes or fit pins into them.

In describing the construction of this appliance the term "post" will be used for the part that fits into the tube on the molar band and the term "pin" will be used for the part that fits into the tube on the other bands.

There are many types of locks that can be used to secure the post in the buccal tube on the molar bands but only three types will be described at this time.

First, the spring lock. The spring lock is made as follows: The end of a suitable piece of wire is fluxed and carried to the point of the blowpipe flame and the end melted back on itself the desired amount to form a ball

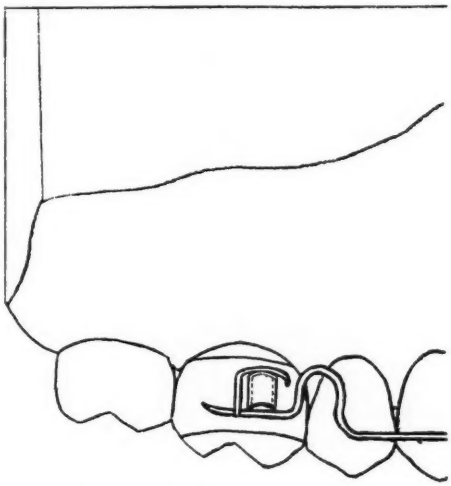


Fig. 16.

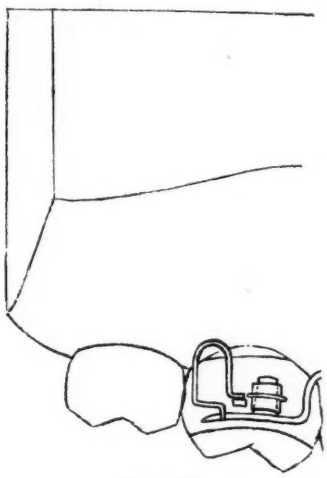


Fig. 17.

Fig. 17-A.

(Fig. 12). To this wire is soldered the post material ½ inch away from the ball. After the appliance is constructed as will be described later the wire extending beyond the post is bent over the second step of the round jaw of the wire bending pliers, so that the ball lies midway with the post from a buccal view (Fig. 13), but slightly lingual to the end of the post (Fig. 14). Fig. 15 shows a view of these pliers.

Second, the soft wire lock: The soft wire lock is made by soldering the post ¼ inch away from the end of the arch wire. About 1/32" either side of the post a slight groove is filed in the buccal side of the arch wire. In this groove is soldered the end of a piece of .026" noxidium soft gold wire, at right angle to the arch wire running parallel with the post. This wire is bent to pass over the end of the post and cut off the desired length as shown in Fig. 16.

Third, the cleat lock: This lock, which can be made of either soft or spring wire, is made as follows: On the molar band is soldered a piece of triangular-shaped wire at right angle to the tube. The thin edge of this wire should be on a line with the occlusal end of the tube and should extend away from the tube .07″. To the arch wire is soldered a suitable piece of wire bent so the end of it will catch under this piece of triangular wire (Fig. 17). This form of lock when made of .025″ spring wire has been found of value in conjunction with the clutch lock here shown.

The maxillary appliances are constructed of round spring wire usually .030″ in diameter. In the mandibular appliance it is found that round spring

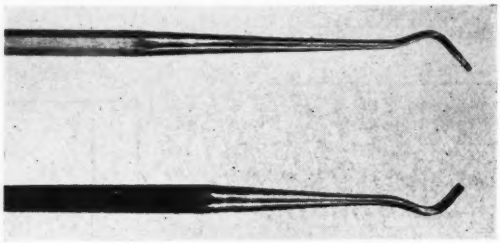


Fig. 18.

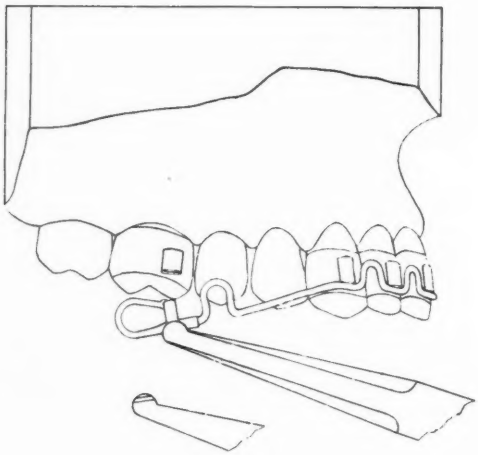


Fig. 19.

wire .028″ for the front section is better. The reason for this is that the loops placed between the pins of necessity are so small that they would not be sufficiently springy if the heavier wire were used.

The material for the arch wire should be thoroughly annealed before it is shaped as desired.

The desired wire of suitable length is placed in a broach holder as previously shown. The post wire which should accurately fit the lumen of the tubes on the molars is treated as follows:

The periphery of the end of the post material is smeared with graphite to prevent the solder from flowing over it. A soft lead pencil is used for this. Next a shallow half-round groove is filed in the end of the post, the groove running the long way of the end of the post.

A small piece of 22K solder is fluxed and placed on the arch wire at the point where the post is to be soldered and fused. The grooved end of the post material is fluxed and then placed on the solder previously fused on the arch wire and the two carried to the flame and the solder refused. In doing this the point of the blowpipe flame is directed on the heavy post material about ⅛″ away from the joint and the solder refused by the heat conducted through the heavier post material. When cooled this joint should be thoroughly tested by springing the two wires in different directions at the same time. If found secure the post wire is cut off about .12″ from the arch wire and then filed down to .10″. It is very important that this post

Fig. 20.

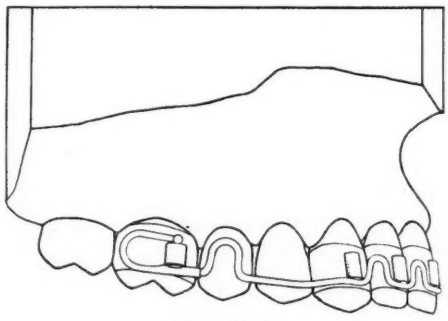


Fig. 20-*A*.

be the exact length of the tube. If it extends beyond the tube, and the lock wire, whether spring or soft, passes over the end of the post, the appliance will be found to work up and down. If too short it permits of more play of the post in the tube which allows the molar to tip under stress.

The arch wire is now grasped with the wire bending pliers having the second step of the round jaw in front of the post and the wire bent at right angles in the same direction as the post. The wire is now grasped in the groove in the third step of the round jaw of these pliers and the wire bent over it. The wire is then grasped in the second step of these pliers at the desired point and the wire bent forward forming a loop as shown in Fig. 17-*A*. The object of this will appear later.

The tube on the molar band is now freed of wax by passing an instrument into it (Fig. 18). The post is dipped in vaseline and the arch wire grasped with modified Howe pliers (Fig. 19) and the post carried into the tube. The arch wire is shaped to lie close to the buccal surface of the premolars and canine and pass over the incisal end of the tube on the band nearest to the molar. With a lancet the wire is marked on each side of the tube. The post is then carefuly withdrawn from the tube and a small piece of 22K solder fused on the arch wire between the two marks previously placed. A half-round wire .019″ × .038″ (please note this is a loose fit in the tube) which is also mounted in a broach holder, is treated as was the post wire; then the groove placed on the solder which was fused on the arch wire, carried to the flame and the solder refused. In doing this the flat side of the half-round wire should be toward you, as it enables a much more accurate placing of the

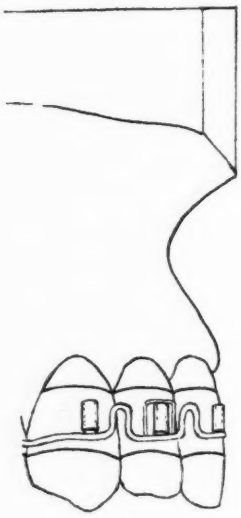


Fig. 21.

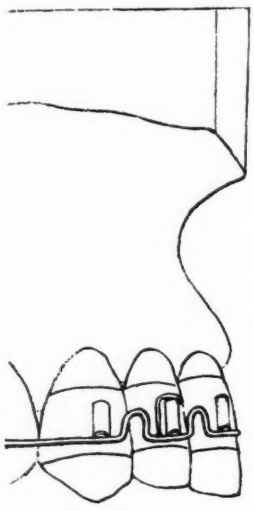


Fig. 22.

pin. The joint is then tested as previously described; in fact all soldered joints in these delicate appliances should be tested in this manner.

This pin wire is cut off .12″ from the arch wire, the end filed to free it of burr and slightly tapered to facilitate its entering the tube. The post is now inserted in the molar tube and the relation of the pin to the tube that is to receive it carefully noted. If the free end of the pin is found to present either labially or lingually, the post should be removed from the tube and the arch wire grasped with two pairs of the wire bending pliers and a torsional bend given to the wire, as shown in Fig. 20. Never try to bend the pin, as this is liable to injure the soldered joint. The post is now placed in the molar tube and the pin inserted in its respective tube. If the insertion of this pin causes the patient any annoyance, careful observation will disclose that the gum has blanched either mesially or distally to the tooth. When this occurs it is not necessary to resolder the pin. The U-shaped loop in front of the post enables the shortening or lengthening of the distance between the post and the first pin in front of it. When the appliance is adjusted so that it is found to lie passive when the post and pin are inserted

in their respective tubes it is removed from the mouth and a suitable U-shaped loop formed in the arch wire between the first pin and where the second one is to be placed. The next pin is soldered as desired and the appliance again tried in, to see that this pin is in its proper relation. If not, this loop is opened or closed as desired. It is important, each time a pin is added to the arch wire, that the appliance should be tested in the mouth to see that it will fit properly, and not cause annoyance to the patient. The balance of the appliance is constructed in like manner and when the post for the right molar is soldered, the excess wire is cut off the desired length from the post.

If the appliance has been constructed as described, it will be found that all the pins will readily enter their respective tubes and that the posts can also be placed in their respective tubes as follows: The arch wire at the left post is grasped with the modified Howe pliers previously shown and the ball

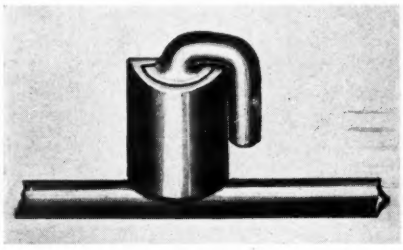


Fig. 23.

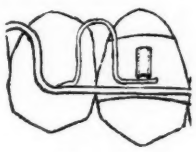


Fig. 24.

on the end of the spring lock (if this type of lock is used) pressed against the buccal side of the tube so that the free end of the post can be carried lingually and enter the tube. As the post is carried home the ball passes up the outside of the tube and springs lingually, thus locking the appliance in place on that side. The other side is inserted in like manner (Fig. 20-A).

If it is found that the appliance causes no pain it should be removed, uniformly annealed and pickled, and then it is ready to place in the mouth. It has been found advisable to have this type of appliance worn for at least a week in the annealed state so as to cause as little soreness as possible. At the next visit it can be removed from the mouth, slightly altered in shape, heat treated and reapplied.

In order to avoid confusion, it is thought advisable to explain what is meant by the terms "annealed" and "heat treated." By annealing we mean that the wire is heated to a visible red and then plunged quickly into water. By heat treating we mean that the appliance should be uniformly heated to a temperature of between 900 to 100 degrees Fahrenheit and air cooled. This of course is best done in an electric furnace.

If you have carefully followed each step in the construction of this appliance you will observe that no provision has been made to lock the pins in place. In many cases it is found unnecessary to do this but in many other cases it is very necessary that they should be securely locked. This can be accomplished in several different ways. Whenever it is necessary to supply a lock to hold a pin in place it is essential that the pin does not extend beyond the end of the tube. On the gingival side of the arch wire $\frac{1}{32}''$ away from the pin a tiny bit of 18K solder is flowed. The end of a piece of fluxed .018″ noxidium soft gold wire is placed on this solder and the solder refused. This is bent to pass down the other side of the pin, cut off, and again soldered

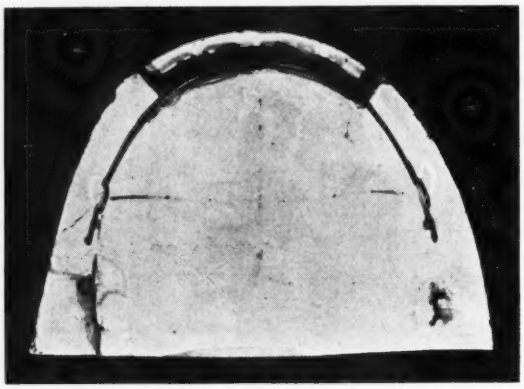


Fig. 25.

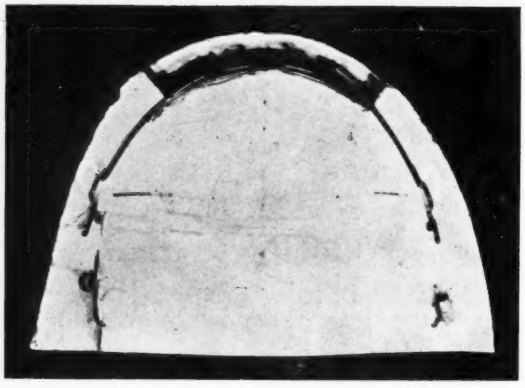


Fig. 26.

to the arch wire. (Fig. 21.) This loop of soft wire can be bent labially to permit the pin to enter the tube and then bent back over the end of the tube securely holding the pin in place. If necessary this type of lock can be used on each pin. The form of lock just described has proved the most positive, cleanly and secure, with no possibility of causing irritation to the soft tissues.

Another form of lock is made by using a heavier piece of spring wire and is only soldered to the arch wire at one end. This wire is bent in the form of an L. (Fig. 22.) In this you will see that there is a free end that is liable to become misplaced. Another form of lock, shown by Dr. George Grieve, is made by soldering the end of a piece of soft wire to the end of the pin. When the pin is inserted in the tube this wire is bent at right angle to

the pin extending over one side of the tube. (Fig. 23.) In practice this has not proved successful, owing to the frequency of breakage, nor has it been found as secure as the first form described.

In many cases where one or more teeth are decidedly malposed, or require considerable rotation it has been found advantageous to use auxiliary springs of lighter spring wire as follows: To a piece of suitable spring wire is soldered a pin ⅛″ from the end. This wire is bent to form a loop and is soldered to the arch wire so that the loop presents toward the gingiva and the pin will enter the tube on the band on the tooth requiring excessive movement or rotation. (Fig. 24.) It is seldom found necessary to lock such a pin in place but if necessary it can be done as described above. One or

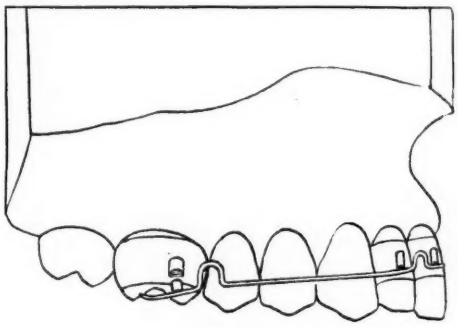


Fig. 27.

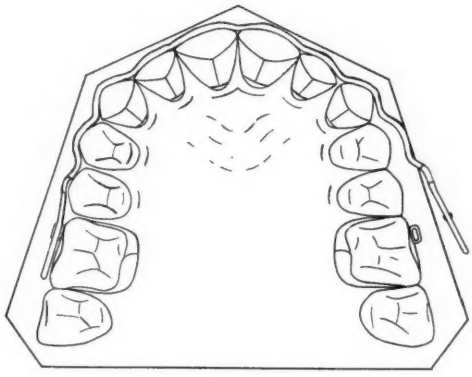


Fig. 28.

more of these auxiliary springs is often used on an appliance. The pin used on auxiliary springs is made of material .021″ × .040″ and you will observe is the same size as the lumen of the tube and therefore a snug fit, but it has been found to be practical to use such pins on auxiliary springs.

The manipulation of this appliance is exceedingly exacting even when properly understood. The attachment of the appliance to the teeth to be moved is so positive that there is practically no lost motion. Due to this fact, when it is desired to alter the appliance in shape, great care should be used. The adjustment of the appliance should never be sufficient to cause pain when reapplied to the teeth. It is never permissible to alter the shape of this type of appliance without removing it from the teeth.

An appliance of this type constructed as described above might be worn

for a year, provided it has not been accidently altered in shape, without causing any tooth movement. It should ever be borne in mind that every atom of force exerted by an orthodontic appliance is in direct ratio to the force exerted by the one in placing the appliance on the teeth.

To remove the appliance the posts should be unlocked and removed from the tubes on the molar bands first, then the pins can be readily withdrawn after they have been unlocked. Where all the teeth in front of the molars are attached to the appliance, it is obvious that the appliance must be gradually removed all around. If the appliance has been tempered by heat treatment it should be uniformly annealed before any attempt is made to reshape it. Failure to do this often results in a broken appliance, necessitating the construction of a new one.

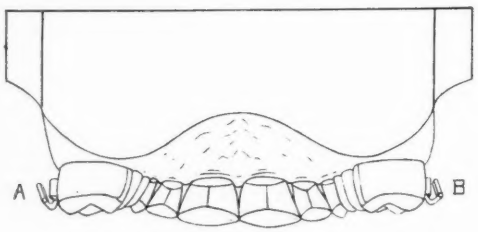


Fig. 29.

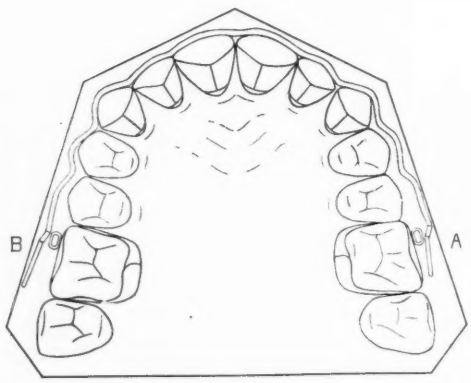


Fig. 30.

In altering the shape of this appliance it is important that only one change be made at a time. The unchanged part of the appliance should be replaced on the teeth as it was formerly and the relation of the remainder of the appliance carefully noted. If the change made is found to be too great it should be corrected before a second change is made.

To carry the anterior teeth forward the loops in front of the posts are opened slightly as follows: The large step of the round jaw of the pliers is forced into the loop the desired amount. Obviously this will change the relation of the pins on the front portion of the appliance to the post, so a second change must be made. This is done by forcing the round jaw of the pliers into the angle formed in the wire in front of the loop. The post of the side of the appliance that has been altered should be placed in its respective tube and the relation of the pins to the tubes on the front teeth carefully noted, or

the pins can be inserted in their respective tubes and the relation of the post to its tube noted. If it is only desired to lengthen the distance between the tube on the molar and the first tube in front of it the post should be made to lie parallel to the tube from both an anterior and buccal view. The extent to which this appliance should be lengthened at one time is not more than the wall thickness of the tube or .014″. The opposite side is adjusted in like manner. The appliance heat treated and reapplied.

If it is desired to create space in the anterior region the loop between the pins that enter the tubes on the teeth that are to be carried apart should be slightly opened. In doing this it is necessary to do as was done when the loop in front of the post was opened; make a compensating bend after the loop is opened to the desired extent. In fact wherever a loop is opened,

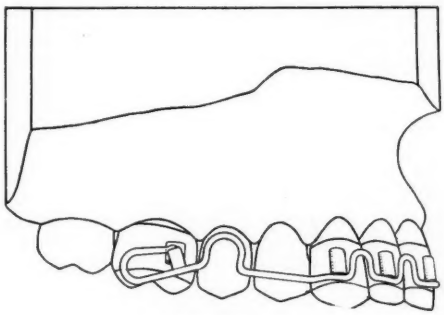


Fig. 31.

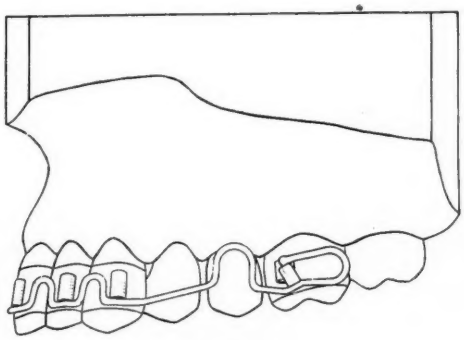


Fig. 32.

or closed, it is necessary to make a compensating bend at the proper place in the arch wire. The extent to which pins should be carried apart, or brought closer to each other should never be more than the wall thickness of the tube or .011″ at one adjustment. It may be thought that this is not enough, but when you recall how positive this type of appliance is and that there is very little lost action you will the better understand the reason for this. After such an alteration is made the side of the appliance up to where the change was made should be reapplied and the relation of the next pin to its respective tube carefully noted.

To rotate anterior teeth the appliance can be slightly changed in form, necessitating slight manipulation to replace the pins in their respective tubes. As the pins cannot rotate, due to their shape, it is obvious that the position of the teeth must be changed.

To carry the root of one tooth labially the arch wire is grasped with two pairs of wire-bending pliers on one side of the pin that is to be altered in position and a torsional bend made. In like manner an equal torsional bend is made in the arch wire on the other side of the pin.

To carry the roots of the four incisors labially a torsional bend is made in the arch wire on each side just back of the pins that go into the tubes on the laterals. (Fig. 25.) In addition, slight compensating torsional bends are made in the arch wire just in front of the posts, to prevent tipping the molars buccally. (Fig. 26.) When the posts are inserted in their respective tubes the free ends of the pins should present labially to the gingival ends of the tubes. The arch wire, where the pins are soldered, should lie in contact and on the same plane with the incisal ends of the tubes. Another way of accomplishing this same movement is to bend the arch wire just back of the lateral pin on either side so that when the anterior part of the appliance is replaced the posts will lie occlusally of their respective tubes, as shown in Fig. 27.

To carry the crowns of the four incisors lingually the arch wire should be reshaped exactly the same as in the preceding adjustment, and, in addition, the loops in front of the posts must be closed the desired extent. This

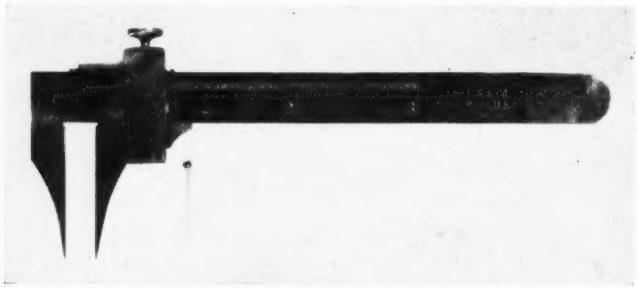


Fig. 33.

does not mean that the loops should be closed excessively, or sufficient to carry the crowns back to the desired position, but just enough so as to not cause pain. It may require several adjustments of the loops and also the front portion, depending on the case, to get the teeth where desired.

To carry the crowns of the four incisors labially, the torsional bends just back of the pins that occupy the tubes on the lateral incisors are made in the opposite direction, the compensating torsional bends in front of the posts are made the same as in the previous adjustment and in addition the loop on each side is opened. When the posts are inserted in their respective tubes it should be found that the arch wire lies slightly labial to the incisal ends of the tubes.

To carry the molars buccally and not change the position of the anterior teeth, the arch wire is bent just back of the pin nearest to the post on each side, so that when the pins are placed in position the posts will lie buccally of their tubes. (Fig. 28.) In addition to this the loops in front of the posts must be opened the desired extent and compensating bends made in the arch wire just in front of the posts to prevent rotation of the molars. If the loops in front of the posts are not opened in this adjustment, the tendency will be to carry the incisors lingually and the molars mesially as well as buccally.

To carry the molars buccally and the incisors lingually at the same time, the front part of the arch wire is reshaped so that the posts assume a position further apart, and compensating bends are made in the arch wire just in front of the posts. It must always be remembered that as the distance between the posts increases, the distance from the arch wire midway of the pins that enter the tubes on the central bands to a straight line from post to post decreases.

To tip the crown of a molar buccally the loop in front of the post is grasped with a pair of flat-beaked pliers in one hand and with the wire-bending pliers in the other hand the wire is grasped just in front of the post

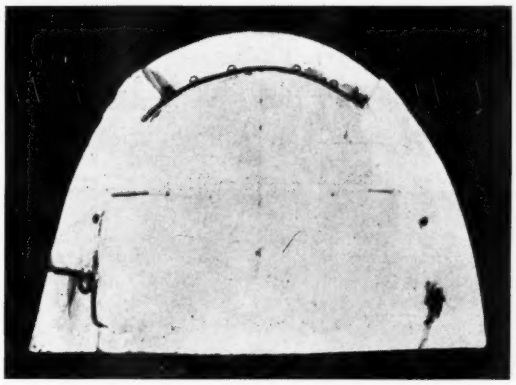


Fig. 34.

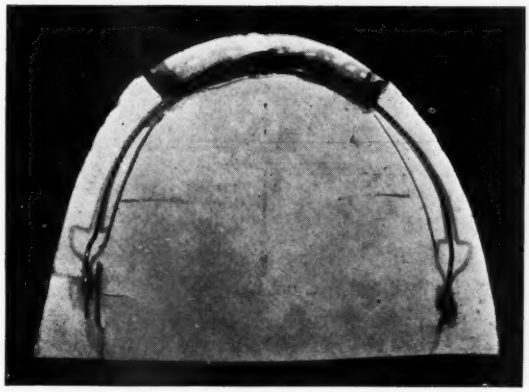


Fig. 35.

and a torsional bend made. This can be done on one or both sides at the same sitting. Or if desirable, one molar can be tipped buccally and the other tipped lingually at the same time. (Fig. 29.) If it is desired to rotate the molars to which the appliance is anchored it can be done by bending the appliance as shown in Fig. 30.

To carry the roots of the molars lingually the arch wire is bent exactly the same as where the crowns of the molars are to be tipped buccally but the distance from post to post at the arch wire must remain the same. Obviously the distance between the free ends of the posts is decreased.

To tip a molar mesially the arch wire is bent as shown in Fig. 31. To tip a molar distally the arch wire is bent in the opposite direction. (Fig. 32.) If the roots of the molar are to be moved either mesially or distally it can be accomplished by the proper bending of the arch wire so that the free end of the post is made to move in the direction it is desired to carry the roots.

Before any adjustments are made in this type of appliance, the distance from post to post or from pin to pin should be accurately measured with a suitable gauge that can be set. (Fig. 33.) By reapplying the gauge to the altered appliance you know how much tooth movement the appliance will accomplish if worn until it has become passive.

It has been claimed by some that the loop is a pernicious and unscientific means of accomplishing tooth movement. It has also been claimed that when the loops in front of the posts are opened or closed, the molars are tipped back or forward.

To demonstrate the fallacy of these contentions a base was constructed as shown in Fig. 34. On the right side round tubes are used to accommodate

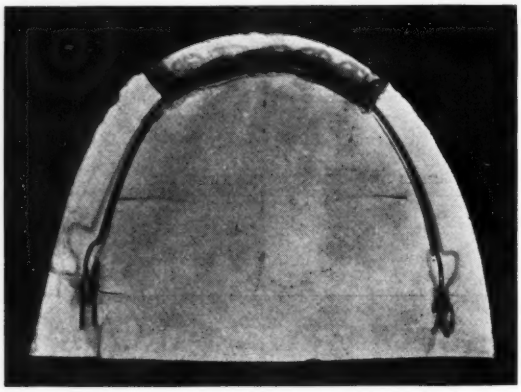


Fig. 36.

the post and the pin next in front of it which are also round. All the other tubes are half round, the kind used in actual practice. In Fig. 35 the appliance is shown resting passively with all the pins and the posts inserted in their respective tubes. Fig. 36 shows what takes place when the loops in front of the posts are opened the greatest extent that will still permit the appliance to be replaced without breaking the elastic limit of the wire. You will observe that on the right side where the two round tubes are the arch wire bows uniformly buccally, while on the left side the arch wire for a distance in front of the post and back of the pin nearest to the post lies practically in the same position that it was previously, and that the wire then bows buccally. The loops on each side of the appliance were opened decidedly more than ever should be done in the application of such an appliance on the teeth. This, of course, was done to more clearly demonstrate what takes place.

The result obtained by this experiment is identical with what would occur if the nuts were turned up excessively on an appliance such as the ribbon arch.

By the intelligent use of this type of appliance one is able to accomplish

any tooth movement that lies within physiologic range. By the proper bending of the arch wire any tooth included in the appliance can be moved as desired, using all the remaining teeth to which the appliance is attached as anchorage against the tooth that it is desired to move. It has proved the most efficient appliance to bring unerupted teeth to their proper position when used in conjunction with an auxiliary spring.

Obviously it can be used to intrude and extrude a tooth, and when necessary in conjunction with intermaxillary elastics.

DISCUSSION

Geo. W. Grieve, Toronto, Canada.—It is a distinct honor to have the privilege of opening the discussion of a paper presented by a man of such recognized ability in the field of orthodontia. Dr. Young has given very cheerfully for years considerable of his time to aid in the development of the science, and has introduced a number of improvements in appliances and technic. Many men are greatly indebted to him for personal help given them in the solution of their problems. On my own account, I would like to take this opportunity to publicly thank him for the great assistance which he has given me for many years. What I consider a very great compliment was the remark by two different men about a year ago, that my technic resembled Young's. His opinions are sought because they are only given after very careful consideration. He is gifted with great mechanical ability and excellent judgment in diagnosis.

In the pin appliance, Dr. Angle, a genius in mechanics, gave us the basis for the most perfect appliance we have, but, like every mechanical device, experience in its use established its good and weak features and also showed its limitations. The original three-piece arch, with its horizontal means of attachment to the molars and its round pins and tubes, was not conducive to the greatest possible efficiency of the appliance. The one-piece arch, and its vertical attachment to the molars, introduced by Dr. Young, eliminated many of the weak points of the original appliance. The small half-round pin and tube, introduced by Dr. Hawley, still further improved the appliance, and made it possible to control perfectly each tooth, and obtain any required rotation with greater ease than was possible with the round pins and tubes.

Dr. Young advocates fitting bands well up to the gingiva, with the incisal edge of the bands upon incisors gingival to the normal contact points of the teeth, his argument being that, where so many bands are used, spaces will exist after their removal. I fitted my bands in this way for some years, and while I feel that it is desirable from the standpoint that it exposes the appliance less to view, there is bound to be more or less irritation to the gingiva, causing slight recession. I prefer to place the bands as advocated by Dr. Angle, the band often covering the contact points. In treatment, the crowns of the teeth are usually carried a little too far labially, or buccally, and, when the bands are removed, normal function of the muscles of the lips and cheeks very soon closes up the slight spacing. It also necessitates a little less work to fit a band nearer to the incisal, or occlusal end of the tooth. I often remove odd bands before the completion of treatment and close the spaces.

I would like to stress the point brought out by the essayist, that the tubes be placed parallel with the long axis of the teeth, and also that the bands be fitted in such a position that the arch wire lies in a symmetrical line.

While I have a very high appreciation of Dr. Young's ability and opinions, I have not been able to see the necessity of loops in the arch wire, as advocated by him, except in occasional instances. Many loops in an arch wire make it more difficult for me to make adjustments, and, while I agree that if we desire to enlarge the whole dental arch by way of expansion and elongation, the loops facilitate this, but I maintain that our technic in this respect is often at fault. I believe that the most constant trend of the migration of teeth is forward, whether the dental arches are under normal width or not. If my contention is

correct, then the movement of many teeth which we are called upon to make is a distal one. Under these conditions loops are rarely necessary. I hope to discuss this point more fully in a paper at Philadelphia next week.

I would suggest that the technic advocated by the essayist for the attachment of the pins be carefully followed, and that the flat side of the pin material present to the operator when soldering. The pins, as well as all springs and locks, should always be soldered at right angles to the arch wire.

The amount of time allotted to a paper at this meeting has not permitted the essayist to cover carefully the detail of construction of this appliance and its adjustment for treatment. It is very important that, in its construction and adjustment, there must be absolutely no interference of any part against another when fitting, as the least pressure will more or less distort it. The arch wire may be slightly bent buccally, or labially, upon both sides of an area under construction or change, permitting the insertion of the pin in the tube in the area of the change singly, and subsequently those upon either side, noting the relation of the appliance to the other parts. These bends are straightened out as soon as the adjustment is completed.

In the use of locks, it is desirable, where possible, to place them upon teeth requiring extrusion rather than upon those which should be intruded. The lock which Dr. Young said I had shown is one suggested by a student in my office, Mr. Halldorson. It has, as the essayist said, the fault that it breaks after being straightened out two or three times, but it is the most practical one for springs, is the neatest of the locks in use, and is lovely for a patient who is going away for several months.

It is important, as brought out by Dr. Young, that a change in one area should be completed before another is started, using the unchanged portion as control. When he says that the unchanged portion should be replaced on the teeth to note the relation of the part changed, that does not mean that if the change were made in the incisor region, for instance, that the pins and posts on both buccal ends of the appliance should be placed in their respective tubes at the same time, as this would often be impossible. Under these conditions, the arch should be slightly bent buccally distal to the incisors, or canines, each buccal end and the incisor section placed consecutively, noting the relation of the remaining parts, these bends being straightened out after completion of any adjustment necessary.

It is not desirable to have two or more adjoining teeth, particularly in the region of the canines and premolars, without an attachment to the arch, unless there are bands carrying tubes upon these teeth, against the occlusal end of which tubes the arch wire may rest, as the appliance is liable to become distorted during mastication. Teeth should often be banded which require no movement at all, simply to give stability to the arch and gain additional anchorage. One of the best features of this appliance is its possibilities in obtaining the necessary anchorage to carry out the movement required.

The essayist gave very little detail of the technic for gaining rotation. The location of the bends in the arch to gain rotation depends upon the character of the rotation required. If it is desired, for instance, to carry the distolabial angle of the left central incisor labially, allowing the mesiolabial angle to remain where it is, three bends are required, a labial one fairly close to the mesial side of the pin for the tooth to be rotated and another immediately mesial to the left lateral and a lingual bend quite a little distal to the left central pin. The simple rotation of a tooth in its socket requires an equal bend in the arch wire close to each side of the pin. There must always be space to permit of the movement of a tooth. Personally, I prefer, after space has been obtained, to accomplish most rotations as well as many other individual movements, with the U-spring. Its action is very gentle, and more can be accomplished with each adjustment than is possible with the main arch.

The essayist explained in detail the technic of adjustment of the arch wire to obtain tipping of the crowns of molars in all directions, as well as carrying their roots where desired. The crowns of molars can also be tipped lingually or buccally very beautifully by having the post soldered to a round tube which fits loosely upon the arch wire, or a spring

may be employed to tip a molar. For carrying the roots of any teeth mesially or distally, or the tipping of their crowns in the same direction, I prefer to use the U-spring, a pin being attached to the spring in the former instance, and the end of the spring fitted against the approximal surface or inserted in the tube for the latter movement.

The essayist employs a gauge to check up the width of the arch. Another method is to make a tracing of the arch on a card. A straight line is drawn across the card upon which the most distal symmetrical pin on each side is placed, and the inner line of the arch traced upon the card. By means of this method an approximate record of the whole arch may be kept. This card may be retained and used for subsequent appointments until a definite change is made in the arch, when a new record is made.

As brought out by the essayist, the manipulation of the pin appliance is very exacting, but I maintain that difficult cases cannot be successfully corrected with simple appliances.

For those who have not used this appliance extensively, I would suggest its application at first in the treatment of several fairly simple cases, gradually working up to the more difficult ones as the operator develops skill in its manipulation.

Dr. Herder, New York.—What gauge wire does Dr. Young use when he makes loops on the labial arch between the incisors?

Dr. Young (closing).—I use 30 to 32, depending on the upper, and for the lower, particularly the anterior section, I use 28 or 29, that is, .028 or .029 in diameter, because there the teeth are narrow and the loops are so small that it would not be practical to put them in if you used a heavy wire.

The gauge on the anterior is given in the paper.

Dr. Grieve said he did not agree with me on the question of loops between the pins. That is an individual matter. I have used them for years and have liked them; somebody else may not like them; they do not have to use them.

THE REMOVABLE LINGUAL ARCH APPLIANCE*

By Dr. John V. Mershon, Philadelphia, Pa.

WHAT I shall present to you today will be a method of orthodontic practice which has been evolved from a period of thirty-seven years of observation and experience in general dental practice and in the specialty of orthodontia.

Nineteen of the years mentioned were devoted to the general practice of dentistry, during which time I had the opportunity of making many observations which have proved invaluable to me in the practice of orthodontia as a specialty. The unquestionable value of this experience in dental practice to specialization, leads me to the conclusion that it is unfortunate, and a serious handicap for young men to begin the practice of a specialty immediately after completing their college course, for the reason that they fail to obtain that broad and comprehensive view of the purposes and aims of dentistry, as a branch of the healing art, that is so necessary to the proper perspective of specialization in one phase of practice.

During the period of general practice, I observed children's dentures grow into those of adults, and adults' grow older and noted the changes that were constantly taking place. I saw cases of apparent closed bite in children develop into edge to edge bites in the adult and I also saw good occlusions develop into open bites; I saw apparent cases of malocclusion in children develop into very good functional dentures without orthodontic treatment; I have seen a splendid occlusion in the deciduous teeth result in a bad case of malocclusion in the adult, and I have seen adults of thirty, with very good occlusions, develop very faulty occlusions at forty.

These observations of the changes which take place in the human denture gave me a concept of the dental problem as a whole that has influenced my practice of the orthodontic specialty and has impressed upon me that there is no period in the life cycle of a human denture at which it remains fixed, or to express it differently, each age or each day of the individual has its normal, and each day differs from every other day. Having seen such conflicting things happen, I very early realized the difficulty of making a diagnosis in a growing and ever-changing human denture. Diagnosis is the most difficult problem confronting orthodontia today.

Of the thirty-seven years mentioned, eighteen have been devoted to the exclusive practice of orthodontia, and during this period I have had a sufficiently large practice to have had probably as many failures as most orthodontists, and the methods of practice which I am about to describe have been developed as the result of observations of failures as well as successes.

My orthodontic experience includes the use of almost all the appliances from the expansion arch with the screw molar bands, the pin and tube appli-

*Read before the First International Orthodontic Congress, August 16-23, 1926, New York City.

ance through its various stages of development, and to a limited degree, the ribbon arch, etc.

My experience with the various appliances mentioned, and my observations of results, together with a study of the physiologic laws involved, has led to the evolution of the method of practice which prompts this presentation today; namely, the use of the removable lingual arch, and it is the application of this appliance to orthodontic practice that I shall endeavor to describe to you.

I developed the removable lingual arch in my practice because the principles back of it appealed to me, and seemed to be applicable to my understanding of the problem with which we were dealing. Just here I wish to point out the apparent reluctance among professional men to assume the responsibility of breaking away from a supposed authority or precedent in practice. Textbooks and literature and long-established precedent in practice seem at times to have such an influence over men, as to be barriers to progress. Men will follow the procedure advocated by literature or by a supposed authority even though it is opposed to a truth they have seen every day in practice.

The lingual arch was not the result of a sudden discovery. It has been with me a process of evolution of a system and method of practice, born of experience and observation of the application of mechanical forces to natural laws of biology. It is quite probable that some form of lingual arch has been used since the beginning of orthodontia, and I have only applied old and established principles in my work.

The impression seems to have gone abroad that I use nothing but the lingual arch. This is not true. I wish to repeat what I have said in all previous papers, that the lingual arch is not a universal appliance, and I shall further state, that there is no such thing as a universal appliance, and furthermore, the orthodontist must recognize that some cases cannot be successfully treated with any form of appliance or any other known method. In many cases, I use the labial arch in conjunction with the lingual arch, and after describing the use of the lingual arch with its auxiliary spring attachments, I shall describe its use in conjunction with the labial arch.

In considering the lingual arch, the question of the technic of making it is of least importance, second in importance, the question of how to use it, and by far the most important of all, an understanding of its effect on vital processes.

THE TECHNIC OF MAKING THE LINGUAL ARCH

The lingual arch is an appliance, so designed as to apply and exert pressure upon the lingual surfaces of the teeth, for the purpose of causing the teeth to change their positions.

It consists of bands around the molar teeth to which half-round tubes are attached, and an arch wire extending around and conformed to the lingual surfaces of the teeth, carrying half-round posts near each end which are engaged in the half-round tubes on the molar bands. To this lingual arch wire are attached various types of springs known as auxiliary springs.

The first essential is that we construct well-fitting bands for the molars

to which the half-round tubes are to be attached. In the maxillæ these tubes should be placed as near the gingivæ as possible without impinging upon the soft tissues, and slightly mesial to the center.

In the mandible, these half-round tubes should be attached as near the occlusal edge of the band as possible and also slightly mesial to the center.

After the bands have been adapted to the teeth, and the half-round tubes soldered in place, the bands are placed on the teeth and a modeling compound impression of the whole denture is then taken over the molar bands. On removing the impression, the bands are removed from the teeth and placed in the impression and a stone model run with bands in place.

The arch wire is now constructed of wire of suitable size and the half-round posts soldered near the ends, in such position that they will properly engage the half-round tubes, with the arch wire close to the lingual surfaces of the teeth so it will lie in its proper position close to the gingiva.

After the appliance has been completed, and placed in position on the model so that it will lie in its proper position, the arch wire is heated with a

Fig. 1.

blowpipe, and while hot, pressed into place with a suitable instrument so that it lies in an entirely passive position. The appliance is now ready to be placed in the mouth.

After the molar bonds are cemented in position, the arch wire is tried in to see that it is absolutely passive. It is then removed, and the lock wire is soldered in position. This is attached to the distal of the half-round post instead of the mesial, as I formerly used it, for the reason that in the mesial position, I found it to be a food pocket and it would at times interfere with the auxiliary spring.

The lock wire should be soldered so that it follows the contour of the soft tissues, and should be so curved that it can be adjusted just under the half-round tube without impinging on the soft tissues.

I no longer make the compound bend just mesial to the half-round post, except in a few cases, and I keep the arch wire far enough from the gingiva to admit of the auxiliary spring without impinging on the gingival tissues.

The arch wire serves only as a carrying wire and it is seldom used for the purpose of tooth movement. All tooth movement is accomplished by the auxiliary springs, for reasons which I shall explain later. The auxiliary spring should not be placed in position until the patient has become accustomed to the arch wire. This usually requires from one to two weeks.

The variety of forms of the auxiliary springs is almost unlimited, and I shall not attempt to describe all of them, but will illustrate a few of those most frequently used. Figs. 1, 2, and 3 show a few of the different types of the auxiliary springs.

There are, however, certain principles to be followed in forming and placing auxiliary springs which I wish to emphasize at this point.

First, and of utmost importance, the auxiliary springs must be made of the right material. One of the principal causes of the failures that some orthodontists have encountered with the auxiliary spring has been due to the

Fig. 2.

use of the wrong kind of wire. I have tried most of the wires on the market intended for this purpose, and have found only one which has proved uniformly satisfactory for auxiliary springs; namely, the S. S. White retaining wire known as their gold and platinum alloy wire. Many of the wires on the market are suitable and satisfactory for the main arch wire.

Another point to be emphasized is that the auxiliary springs should nearly always be attached on the gingival surface of the arch wire. There are a few exceptions to this.

The value of the auxiliary spring may be destroyed by the method employed in soldering it to the main arch wire. One should never use higher than fourteen carat solder for this purpose. The soldering should be cut in pieces of proper size, then fused to the auxiliary spring wire, after determining the position to which you require it soldered to the main arch. Then it is heated over the flame, and when the arch wire reaches a temperature which you will recognize as the melting point of fourteen carat solder, just touch the end of the auxiliary spring wire which has previously had the

solder fused to it and the solder will melt almost instantly and at the same time they should both be removed from the flame. If this is properly done you remove comparatively little temper from the auxiliary spring wire. The auxiliary spring wire should always be attached at an angle of forty-five degrees to the main arch and then bent around to the desired position. The wire will always bend in its softest spot, which is at the point of soldering, and in this bending, as is well known, will again restore the temper of the spring. If too much solder is used it leaves a hump where you make your bend to such an extent that it is an annoyance to the tongue. If the auxiliary spring is properly placed it will lie directly underneath the main arch wire. Should it cause the main arch wire to raise from the position where it rested before you attached the auxiliary spring, you have too much pressure on the springs, and they should be readjusted.

Fig. 3

The following are the sizes of wire and tubes that I have found most satisfactory:

For labial arch wire	40 – one thousand
For lingual arch wire	38 – one thousand
For lock wire	22 – one thousand
For auxiliary spring wire	20 – one thousand
The length of the half-round tube	10 – one thousand
The length of the buccal tube for labial arch	¼ inch long to fit the 40 thousand wire.

A description of this character is most unsatisfactory. The only way to satisfactorily teach the lingual arch work is clinically.

APPROACH TO TREATMENT

I do not regard the lingual arch as a panacea for all orthodontic ills. In the development and use of the lingual arch, I have had all of the troubles in the orthodontic vocabulary. The reasons for the extensive use of the lin-

gual arch in my practice, in preference to the other appliances I have used, are: first, I have been able to obtain far more satisfactory results; second, I have obtained them while having the patient wear appliances over a much shorter period of time; third, the appliances are far less objectionable to the patient and give the orthodontist less trouble; fourth, you can leave the appliance on or off over a long period. If you leave them on, the teeth will move to the limit of the spring in the appliance and from that time on, the teeth can adjust and adapt themselves according to Nature's plan. If you remove them, with adaptation going on all the time as it does during treatment, you will not have a relapse as a rule, and many times there is an improvement. The fifth reason is that if properly used the occlusal relationship of the teeth can be established in the position where *they will finally stay*,

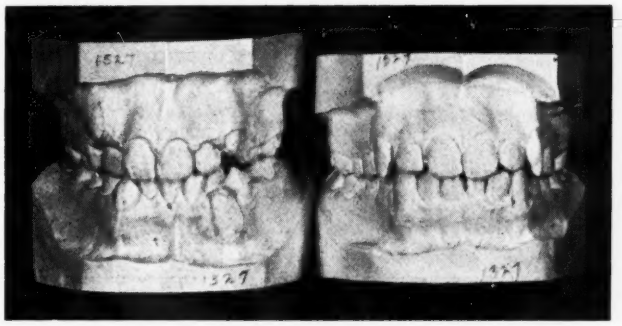


Fig. 4.

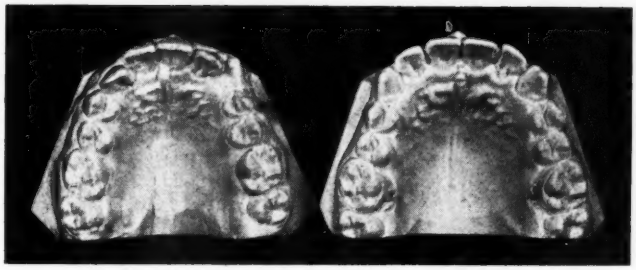


Fig. 5.

without the use of any form of retainer; in fact, I have used no form of retainer for ten or twelve years.

In order to obtain satisfactory results in treatment with the lingual arch, an understanding of certain principles which are fundamental, together with certain natural laws, is necessary. The orthodontist cannot ignore these accepted laws of biology and hope to succeed in his procedure in treatment. The foremost of these are: form and function are one, and all tissues have their normals, as they are related to the other tissues and parts. An organ out of function atrophies. Remove the eye and atrophy of the optic nerve results. Bind your arm to your side for a number of months and there will be a decided change in all tissues. No change ever takes place in an organism except it is in response to some form of stimulation; but stimulation may be advantageous or it may be harmful.

We must realize that heredity establishes the possibility of development, as well as a limit, beyond which we cannot successfully pass with orthodontic procedure. It establishes the size of our hands and feet, our height, the color of our eyes and hair. What is it that determines the size of the crown of the tooth if it is not inheritance? Why do teeth erupt to a certain occlusal plane? We must concede the possibility of inheritance having an influence over the size, form and shape of the dental arch, admitting the variation resulting from environmental influences. Since environment may prevent our ever attaining to the fullness of our inherited possibility, is it not reasonable to assume that the same is true in the human denture? We cannot ig-

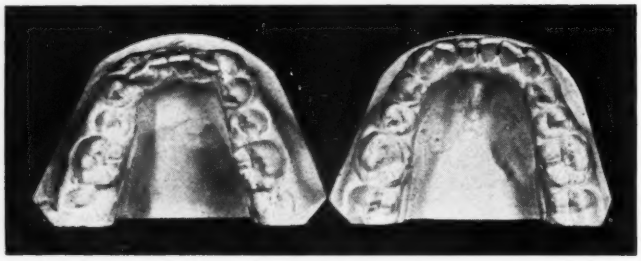


Fig. 6.

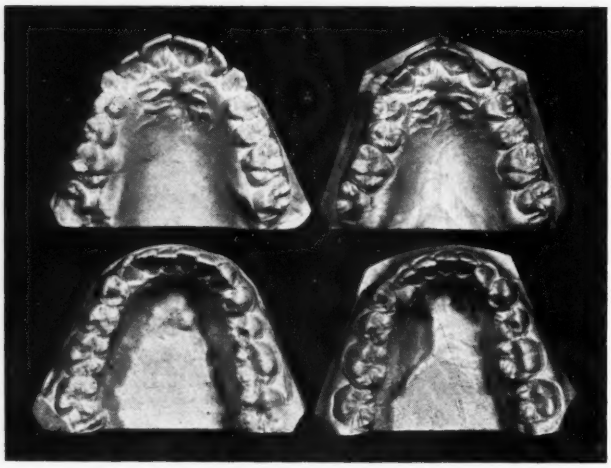


Fig. 7.

nore either heredity or environment in our treatment. Granting that none of us know when in our treatment we have reached the limit of inherited possibilities, in other words, we do not know what normal is for any case we have ever treated, or when we attain it in our treatment, I believe that we cannot move teeth beyond this limit, unknown though it is, and have the teeth remain in this position, irrespective of the mode of treatment or how long they have been retained. Fastening teeth rigidly to an appliance, either for the purpose of tooth movement or retention or moving teeth more rapidly than developmental changes would normally take place, is a transgression of the foregoing laws.

I cannot understand why these and other natural laws which are so well

known to the orthodontist in theory, should be so ignored by him in practice. He theorizes according to biology and practices according to mechanics.

In orthodontia, as in other sciences, certain words seem to be very satisfying, but they often fail to express the full meaning of the thing described. Normal, as related to the occlusal relationship of the teeth, has been looked upon as something exact and definite. In orthodontia, as in every other science, each period reveals truths and steps in progress which prove the former theories and practices to have been wrong, so it behooves us not to be too dogmatic in our statements for we are dealing with the unknown, so at best our concepts must be largely hypothetical. To Dr. Johnson and Dr. Hellman is due the credit for giving to the orthodontic world the correct understanding of orthodontic normal. The great change in the conception of this term is that of shifting it from meaning the absolute idealized position of the

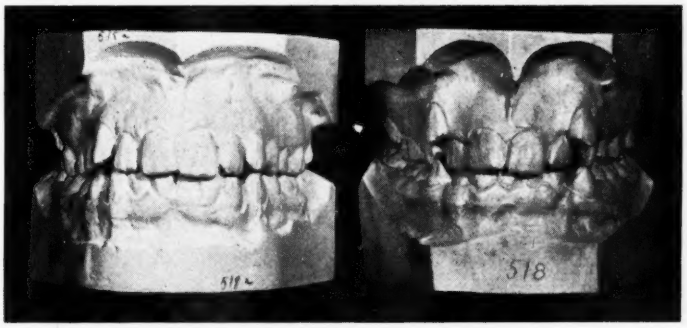


Fig. 8.

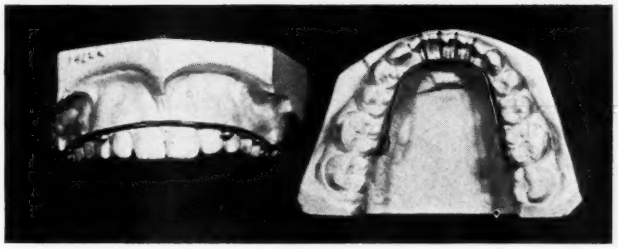


Fig. 9.

human teeth to the position of meaning the harmonious functioning of the correlated parts of the oral cavity and the organism as a whole, and it is this concept that I refer to when I use the term "normal" in this paper.

The generally accepted understanding of normal today in medicine is not the perfection of size, shape and form of each individual organ, but rather the harmonious functioning of all of the organs. For example, take the human vital organs, the heart, lungs, liver, kidneys, etc. It is the harmonious functioning of all of these organs, as related to each other, that constitutes normality, not whether the heart of the individual comes up to some specified standard, arrived at by comparing thousands of hearts and selecting the one most perfect. Should the heart of an individual in whom the vital organs are functioning in the most harmonious manner become diseased so that its functioning is impaired, then all of the other vital organs

associated are, of necessity, affected, and the whole individual becomes abnormal or ill.

It is almost unthinkable that anyone should consider normal occlusion of the teeth as just their definite, mechanical relationship, yet literature and past practice seem to point to this understanding. It is not just a question of moving teeth to a prescribed position. If we wish them to stay, this movement must be brought about in such a way, and at such a period, that a harmony of all related parts is obtained, and this harmony of parts should be *maintained* all through the period of treatment if we expect to *retain* our results. In my opinion, the principal cause for failure is that men are only thinking of tooth occlusion and moving teeth to achieve this, and disregarding any abuse that may occur to the related parts and supporting structures. Normal is so individual that we do not know when we have even attained it in our treatment. Normal is not confined to form alone. There is a normal

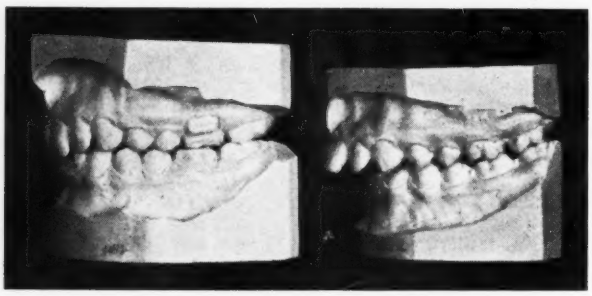


Fig. 10.

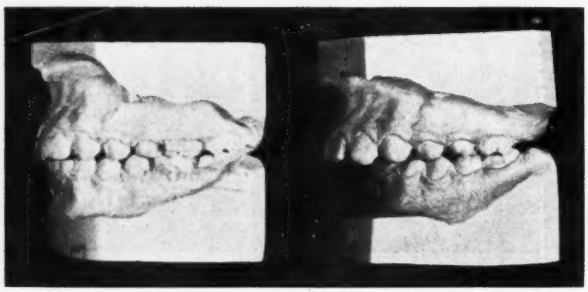


Fig. 11.

of function. Since form and function are so inseparable, each one constantly modifying and changing the other, we must think of normal as embracing both. All teeth have a slight motion and in using the auxiliary spring on the lingual arch, the springs are so small and exert such a slight pressure that during mastication or even the force of the lips or cheek this pressure on the teeth will admit of all motion normal to those teeth in spite of the auxiliary spring. Any appliance or procedure that limits this natural motion of the teeth, limits the tooth function. So, in our treatment, to interfere with a normal function is to prevent a normal form. In correcting a case of malocclusion, where we have moved the teeth to their normal, we cannot hope to have these teeth remain in their new position unless all of the correlated tissues, bone, peridental membrane, circulation, muscular attachments, mus-

cular habits, nervous system, nutritional supply, waste and all the chemical reactions incident thereto have been changed to conform so that they are normal in relation to the new positions to which we have moved the teeth. Should we, in our treatment, throw any one of these correlated tissues out of function, we will have all correlated parts, as well as the teeth, out of harmony the same as the diseased heart, above referred to, produced an abnormal condition in all related vital organs.

In approaching treatment with the lingual arch, unless one has the fundamental understanding of the problem as I have endeavored to outline it above, I should advise him to use some other form of appliance.

I use the lingual arch with its auxiliary springs because I believe it gives the greatest possible latitude to natural processes and interferes least with them. In the use of the lingual arch appliance practically all tooth movement should be accomplished with the auxiliary springs, and the springs should be of such material and such size that the *minimum* amount of force necesary to produce tooth movement should be applied. After these springs

Fig. 12.

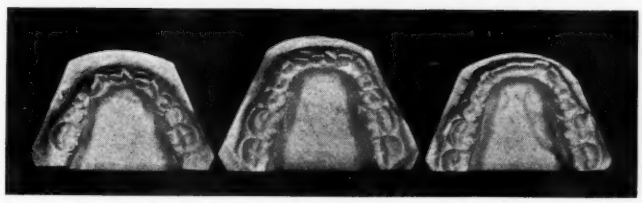


Fig. 13.

have been adjusted with the proper amount of pressure, they should not be adjusted again until all of their force has been expended and then they should be allowed to remain passive for some time after that. It is seldom that I make a readjustment on the auxiliary springs oftener than every three to eight months. It is in this passive period that the teeth have the opportunity of that adjustment which takes place in functional adaptation whereby they may find the positions of their normal for that age. This is in itself retention and the only form of retention to which a developing organism will react favorably, and this retention cannot possibly take place in teeth if they are held or supported by any form of an appliance, and frequently in this period the appliance should be entirely removed. This rest from treatment is really a stage in treatment. It is more than likely that we bring about the change in the position of the teeth far more rapidly than the changes take place in the correlated tissues. When you remove your appliances for a tissue rest or readjustment, you should not place any form of a retainer for the purpose of preventing their return toward their former position; should your teeth relapse to some extent at this time it is evidence that you have produced tooth

movement too fast or at an earlier age than development would normally take place, and your case is better off by having the teeth settle into their normal for that age, and your relapse may be a blessing in disguise. Too many orthodontists, in treating a case of malocclusion in a growing child, have the idea that they must do everything. They forget that growth is the business of *youth* and it is astonishing how much development will take place if we but give the organism a chance. In a growing child we cannot definitely determine the exact positions the teeth will finally occupy, or the exact width of the jaw, or its exact length, or the exact overbite, any more than we can determine the child's exact height and weight, the size of his feet, etc., at maturity. We can only approximate or guess at these things, and for this reason alone, we must depend on natural processes wherever possible for the work. The lingual arch by virtue of its position admits of these natural developmental processes since the natural direction of growth is away from the appliance.

A question to be considered is the stage at which it is best to begin treatment. The old practice of beginning the treatment of every case just

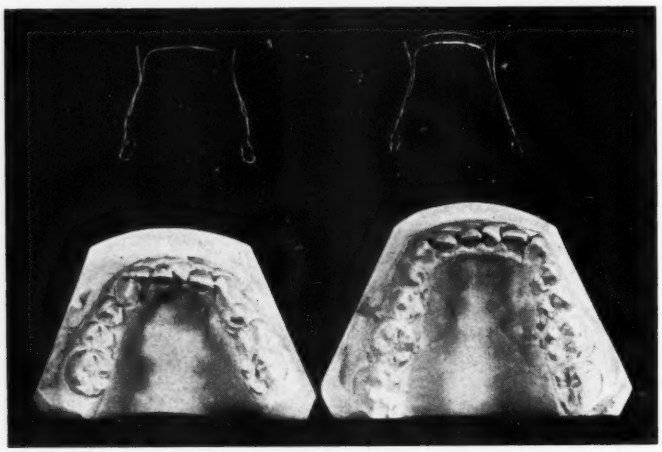


Fig. 14.

when it presents itself is not good orthodontic practice. There is a time in the life history of every case at which it is best to begin treatment. I shall not go further into this subject here since this paper is not intended to deal with diagnosis.

After the diagnosis is made and it is decided that the case requires treatment, there seems to be quite a difference of opinion as to just what the first step should be. For the sake of convenience, we will take our treatment in the following order: first, the one in which the lower molars are distal in relation to the uppers; second, in which the relation of our molars is normal; third, in which the lower molars are mesial in relation to the uppers; fourth, in which we have a unilateral distal occlusion. In cases where the lower molar relation is either mesial or distal to normal, with some few exceptions, my first procedure in treatment is to correct this molar relationship. Besides this being a good mode of procedure, there is a psychologic reason for it. In the conditions in which we need to employ the intermaxillary elastic

bands, we have to depend on the faithfulness of our patients, and children are likely to follow our directions more closely when treatment is first begun than later. Another reason is that changes seem to take place more rapidly and with greater ease in the early stages of treatment.

After establishing the proper relationship of the molars to the extent of reasonable assurance that they will remain, I remove all appliances for quite a long time, say, a number of months, but keep the case under close observation, for there are many changes in the nature of readjustments and adaptations which must take place in all the correlated tissues. Changes and read-

Fig. 15.

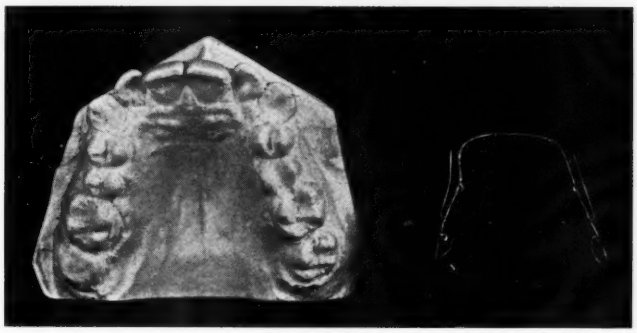


Fig. 16.

justments must take place not only in the osseous tissues but in the muscles, their actions and habits, and probably structure as well, for after changing the molar relations the mandibular action must be modified to some extent, the circulatory system must undergo a readjustment as does also the nervous system; in fact, every tissue that goes to make up the oral cavity must undergo a change. We cannot change one of these organs or tissues without modifying all the others, and to proceed further before these changes take place is only to produce a further tissue disharmony.

After this period of rest and readjustment, we are really treating a neutral occlusion case and it will be found that the time that the appliances have been off has not been wasted, for it will be as though we were starting a

new case, and the progress will be more rapid and results accomplished with greater ease than if we had made the treatment continuous, always remembering that the developmental processes in growth are ever present in a growing child. It is this developmental process that causes teeth to change their positions *and not our appliances.* The fact that our cases do progress more rapidly with less effort when we first start, and that there is a gradual slowing up the further we proceed with treatment, is to me an evidence that we do produce a disturbance of our correlated tissues and a disharmony of parts. Another evidence of this disharmony being produced by too much treatment is that, after you remove your appliance for a time, say a number of months, your case will again progress more easily and the teeth seem to move in a more natural way. This also illustrates that we cannot move teeth just as fast as we see fit, and that the speed of tooth movement cannot be any

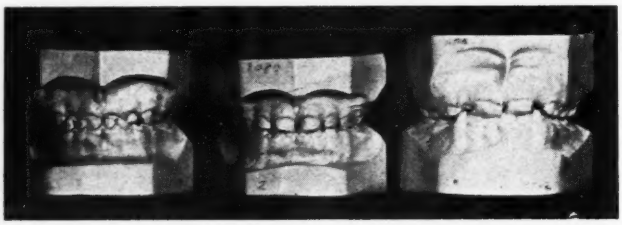


Fig. 17.

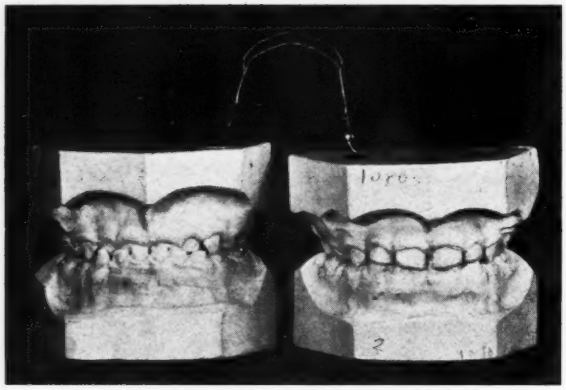


Fig. 18.

faster than collateral changes take place, and this varies with each individual. Figs. 4, 5, and 6 show a case under treatment, appliances just removed to show extensive tooth movement without tipping. This movement was accomplished in a year and ten months. Compare this to Case A, similar types of malocclusion but a great variation in the way they respond to treatment, showing there is no definite formula as to how fast tooth movement will take place or how frequently appliances should be adjusted. Figs. 7 and 8 show possibility of lingual arch with auxiliary spring in treatment. Patient had rickets as child and is still below the average physically. The treatment of this case covered a period of about six years. Case A as compared with Case B.

Orthodontic treatment should not be continuous. It should be taken up

in stages to correspond to the growth periods of the dental arches of the individual, which are manifested by the erupting of the permanent teeth. We have the incisors and the first permanent molars erupting, which designates a period. We have the premolars, cuspids and second molars at another time, which indicates another period. We have the period of pubescence, that period of greatly accelerated growth and development, at which time there are very marked changes in the whole organism. This might be termed the rounding out or finishing period, for it is in this time that we see boys and girls, almost overnight, develop into men and women. It has been my observation that most cases of orthodontia *which really require treatment* cannot be considered finished until within this period because it is the last

Fig. 19.

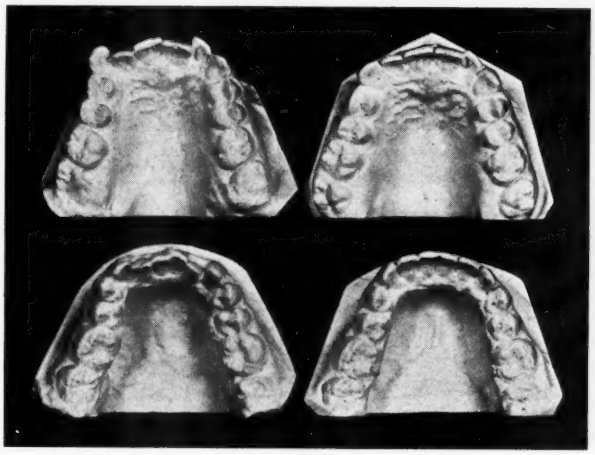


Fig. 20.

of the active growth periods of the child as well as the finishing period, and teeth which have been moved long before this period have been moved before their normal growth period and by so doing we may produce a disharmony of parts. I cannot emphasize this too strongly. After considering this, is it not reasonable that orthodontic treatment should not be continuous, but should be taken up in stages?

For the want of space and time, and since the general mode of procedure of using the labial arch on the upper teeth and a lingual arch on the lower, in treatment of most distal occlusion cases is so well established, I shall not go into the detail of the procedure in treatment in this paper. I shall discuss my procedure in treatment of certain types of closed bite distal occlusion cases.

In the treatment of the closed bite type of distal occlusion case, I have found the following procedure most satisfactory; that is, the use of the upper labial arch with hooks for the rubber elastics in the usual way with the lingual arch in the lower. To the lingual arch I solder four, and at times six, hooks which rest over the edge of the incisor teeth and, at times, the cuspids, and which exert a slight downward pressure. These hooks will readily depress these teeth as shown in Figs. 9 and 10, showing lower depressor and upper labial as arranged for treatment of a closed bite distal occlusion. Fig. 10 shows case before and after treatment, where lower depressor has been used. Fig. 11 shows effect of depressing lower anterior teeth in a closed bite case

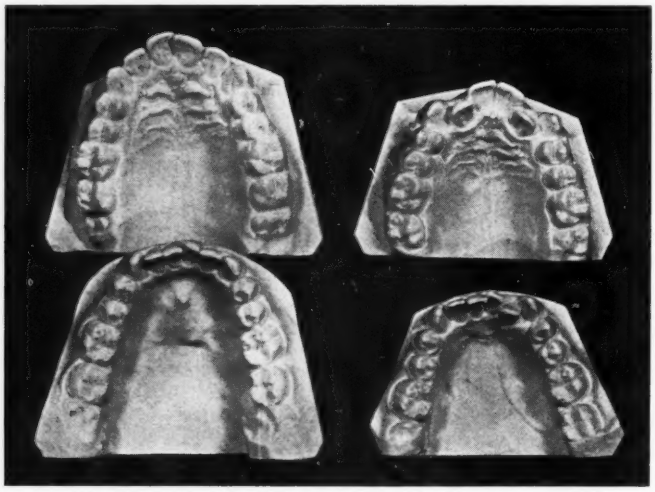


Fig. 21.

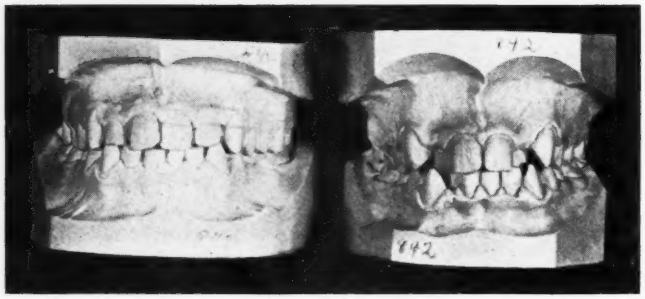


Fig. 22.

and Fig. 12 showing effect of depressor on the so-called curve of Spee, and this procedure in most cases is successful.

If there is any one step which I consider of most importance in the treatment of neutral occlusion cases where we usually find a lack of lateral arch development, in the cuspid and first bicuspid region, with lapped and rotated centrals and laterals, it is to establish the correct position of the permanent cuspid teeth, being sure to make sufficient room for the correction of all incisor rotation. Never undertake to correct any rotation until you have ample room to do it. To obtain the proper lateral development of these teeth after placing the lingual arch, we attach two springs to the main arch

so that they can engage each cuspid tooth and, if necessary, later the bicuspids. After we have secured sufficient lateral development, we leave these two springs in place but perfectly passive. Then we attach a recurved anterior spring to carry the anterior teeth forward. Fig. 13 shows a stage and procedure in treatment, cuspids moved laterally with auxiliary springs. In Fig. 14 the incisors are brought forward with recurved auxiliary spring,

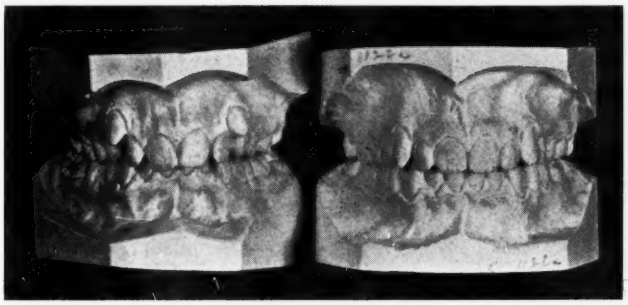


Fig. 23.

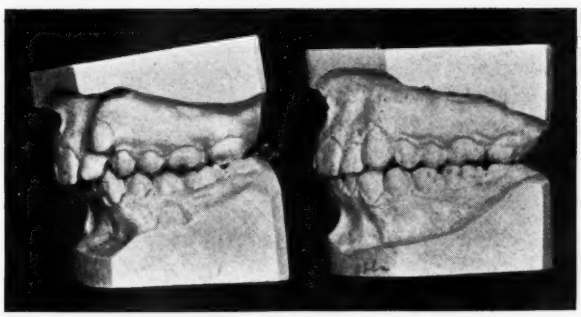


Fig. 24.

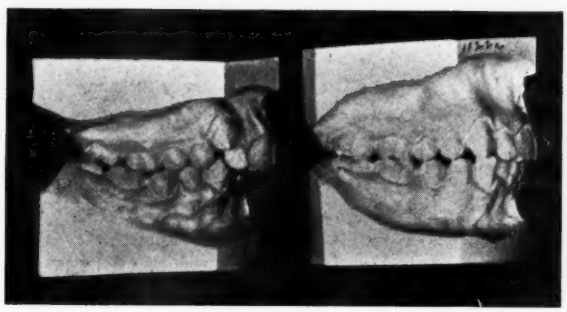


Fig. 25.

and this spring will frequently correct rotation if you do not hurry your case too fast, but in case it should be necessary for further rotation, then tie a silk around the tooth to be rotated and bring it through and around the auxiliary spring, *never the main arch*, and tie in the usual way. It may be at times necessary to band some of these teeth as in rotating cuspids and bicuspids. They should nearly always be banded, but always tie the rotating silk to an auxiliary spring.

The importance of establishing the proper position of the permanent cuspid teeth through treatment cannot be too strongly emphasized. We fre-

quently find laterals rotated on the left side with apparently a prominent cuspid tooth on that side. The trouble is the result of the cuspid on the opposite or right side being out of place. Our treatment in this case would be a lingual arch on the upper with an auxiliary spring to move the upper right cuspid and in turn the laterals, centrals, etc., and the apparently prominent cuspid on the left side, you will find, will drop into place without any fur-

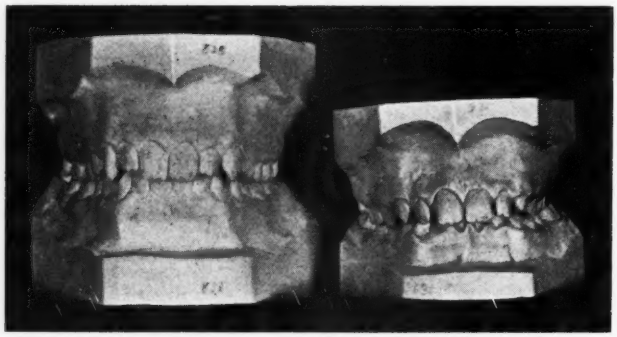


Fig. 26.

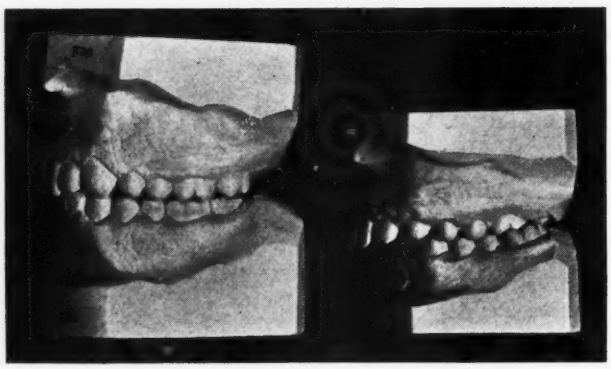


Fig. 27.

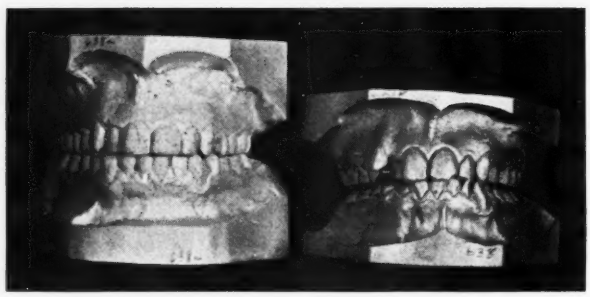


Fig. 28.

ther treatment. In this same case we frequently find the lower left cuspid needs bringing out. It is at times difficult to determine just which cuspid tooth is in its normal position, but in making a careful analysis of the patient's facial lines, in relation to the teeth, you can usually determine which tooth should be moved. I consider this one of the most important steps in treatment, realizing, of course, that symmetry does not exist in Nature, and

that natural processes must always be the determining factor in deciding where teeth will finally stay after we are through with our work. Fig. 15 illustrates the difficulty of determining which cuspid tooth is abnormal.

To accomplish the general widening of the cuspid and bicuspid region, I use the recurved spring as shown in Fig. 16.

In treating mesial occlusion in younger cases where the upper incisor teeth are lingual to the lower, we proceed by placing an upper lingual arch with auxiliary springs and move the upper anterior teeth over the lower anterior teeth. This is accomplished in the majority of cases with compara-

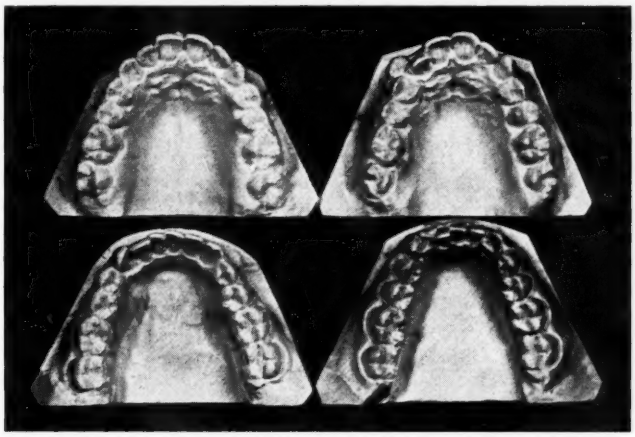


Fig. 29.

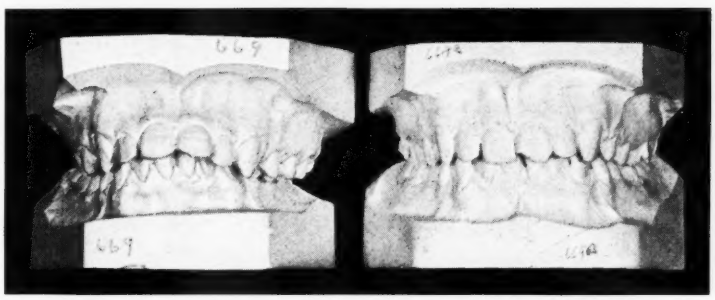


Fig. 30.

tive ease in a few months and without any appliance on the lower whatsoever. After we have moved the uppers so that they are labial to the lowers, we remove all appliances and leave them in this condition a sufficient length of time to allow all possible readjustment and adaptation to take place. Figs. 17 and 18 show Class III treatment in the deciduous teeth. Fig. 18 shows type of appliance used. It may take from one to six months or even a year or more. In some cases, but not all, the mesial-distal relationship is to a large degree corrected. This is one exception where I do not start treatment by correcting my molar relation first. Should it be necesary to use intermaxillaries, we place our lower labial, with long hooks on the labial arch, with an upper lingual, and hooks on the buccal side of the molar bands, and start with our intermaxillary elastics. On certain types of cases we use either a

pin and tube or ribbon arch on the lower, not for tooth movement but for stability of anchorage.

In the past, the type of case where the upper laterals are in contact with the first bicuspid or nearly so, have been considered difficult cases to treat. I have found the following method satisfactory: the auxiliary spring soldered to the lingual arch well back toward the half-round post and running forward and recurved to engage and curve around the lateral tooth, with a little protecting spring soldered on the occlusal side of the main arch to catch under the mesial bulge of the first bicuspid. This little protecting spring acts as a stabilizer to the molars, and it is almost a universal practice to use these stabilizers, especially in the upper where I am using an auxiliary spring for the purpose of anterior movement of the incisor teeth. Fig. 19 shows a stage in treatment moving laterals forward to make room for cuspids. At this stage I would remove the appliance for natural readjustment to take place.

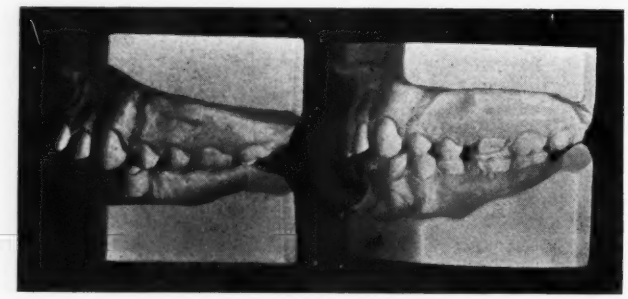


Fig. 31.

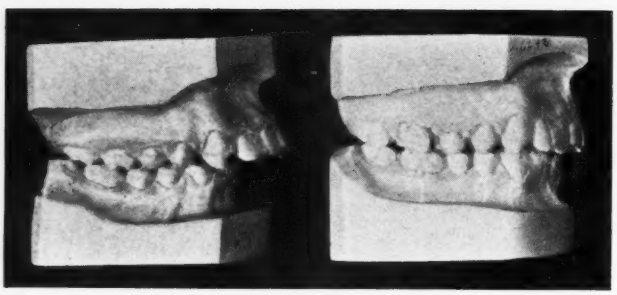


Fig. 32.

Many men seem to have great difficulty in treating unilateral distal occlusion. The following procedure has proved very satisfactory to me. I use the labial arch above in the usual way with a rubber elastic extending from the hook on the labial arch to a hook on the molar band in the lower on the side that is distal. The hook for the intermaxillary on the lower molar band should be soldered at the mesiobuccal angle without any lingual arch in the lower at all. You may be afraid of molar rotation without this lingual arch in place; while it does at times occur, yet it is easily corrected.

I am showing a number of cases before and after treatment which will be recognized as difficult cases, to show the possibilities of what can be accomplished with the auxiliary spring on the lingual arch, where the work has been accomplished as nearly as it is humanly possible to determine, within

the range of natural laws of growth. No retainers have ever been used. All of these finished cases are models from two to five years after the cases were finished.

In this series of cases which are to follow, the last impressions taken were all of modeling compound and were taken just before I wrote my paper, having sent for the patients for this purpose.

Fig. 20 shows first stage in treatment where appliances have been removed and left off for a number of months so that natural adaptation can take place. This is a tissue rest period.

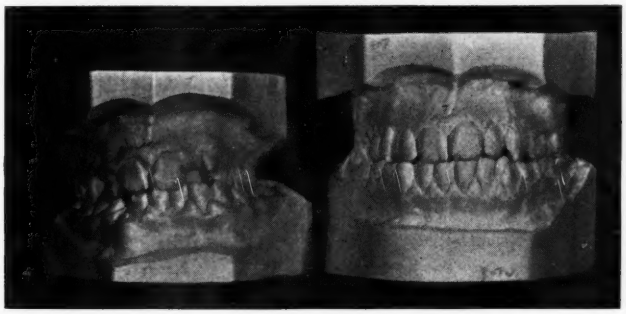


Fig. 33.

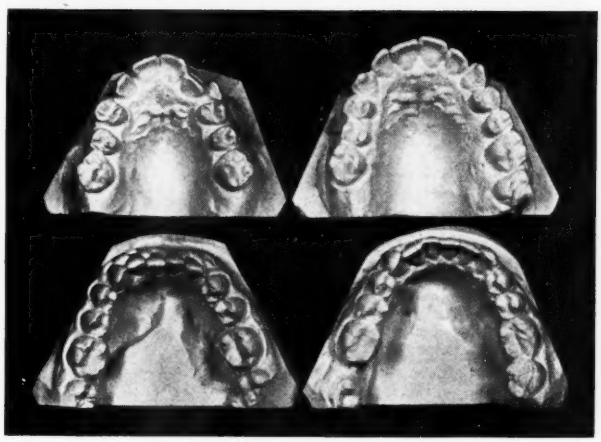


Fig. 34.

Figs. 21 and 22 show a stage in treatment showing a rest period where appliance has been off for two years. Patient took trip around the world. Patient was a dwarf. This figure shows that teeth will stay if moved within range of natural laws of growth without retention.

Figs. 23, 24 and 25 show distal occlusion case before, and quite a long time after, completion. This is the type of distal occlusion case in which the upper molars have to be moved distally. This is accomplished by allowing the labial arch to remain off of the upper anterior teeth.

Figs. 26 and 27 show distal occlusion treated lingual arch below and labial above to show that lower incisors will come bodily forward if properly handled. Finished results a long time after treatment. No retainer ever used.

Figs. 28 and 29 illustrate a case before and after treatment and no retention used.

Figs. 30, 31, and 32 illustrate lower left entirely lingual to upper also distal; also show possibilities in treatment of lingual and labial arches combined with auxiliary springs on both labial and lingual.

Figs. 33, 34, 35, and 36 show possibilities of auxiliary spring work without tipping the teeth in an extreme case of malocclusion. No retention ever used.

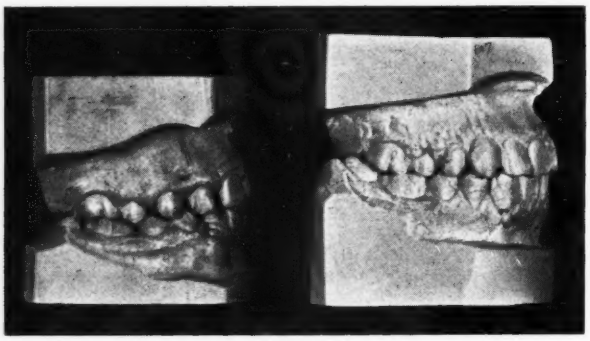


Fig. 35.

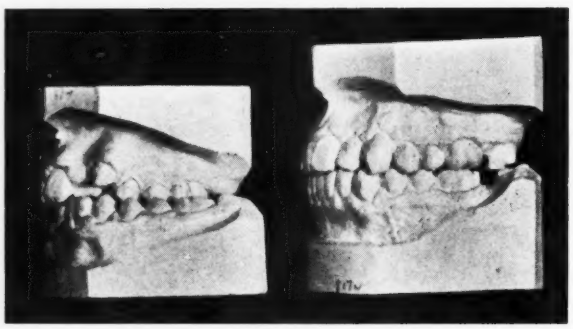


Fig. 36.

CONCLUSION

The lingual arch is an exceedingly difficult appliance to use, and much harm can be done with it, and much harm has been done. It is probably capable of a wider range of action than any other appliance. With the auxiliary spring, you can apply a pressure so gentle that the patient is not aware of it, or you can go to the other extreme and produce tooth movement so rapidly that the teeth will be tipped almost out of their sockets. The tipping of teeth is only an evidence of one's inability to handle a delicate appliance and an expression of one's lack of knowledge of growing and developing processes.

If the orthodontist would only think in terms of treating the supporting and correlated structures and not of tooth occlusion, he would have less trouble in treatment and fewer failures.

In using the auxiliary spring, the minimum amount of pressure that is necessary to produce tooth movement should always be used, never the maximum.

Orthodontic treatment should not be continuous, but should be taken up in stages.

We should not move teeth just at any speed that we see fit. The speed at which teeth should be moved should be in conformity with collateral development, and this is just as variable as all other human qualities are variable.

Because of the variation in the size, shape and form of the teeth, their cusps, their inclined planes and their contact points, in spite of that inherent effort on the part of Nature to develop to its normal, we do not know just what normal occlusion is in any given case. It must be that adjustment which takes place in growth through functional adaptation, which finally determines the relationship of the teeth which is normal to each individual. Any form of appliance or retainer which will inhibit this adjustment prevents the very result we are trying to accomplish.

This paper is just an expression of a point of view, and a partial history of my method of procedure in practice, with the hope that it will at least do no harm. Should there be just one thought that will benefit humanity, my efforts will not be without their reward.

DISCUSSION

Dr. Walter H. Ellis, Buffalo, N. Y.—Dr. Mershon has given us just the masterly paper that we can always expect from his pen. His writings are safe and sane, replete with common sense, backed by biologic and physiologic facts. They ring true.

His opening paragraphs give to his opinions a weight that cannot come with those of the younger generation of orthodontists: for he admits of thirty-seven years practice. With all those years behind his judgment his voice is authoritative.

His well-rounded professional experience has proved most fortunate for orthodontia. I believe, however, that as a general thing the early specialization which he condemns is not quite the handicap he fears. To my mind the broadening influences are more prevalent in our special field than in general practice. Give the young man the very best educational foundation obtainable: then the earlier he limits his practice the better for him and his clientele.

The main point in his essay has been principles of development, not technic. We must not overlook this fact in discussing it. Secondly he has presented the lingual arch for the stimulation of that development which will result in as nearly normal occlusion as the laws of their "individual normal" will allow and as reasonably normal function as is possible in our over-civilized environment.

He is not even dogmatic in the selection of this type of appliance for all cases. I would also emphasize his honest conservatism. The lingual appliance is not a universal appliance. The experienced, thoughtful orthodontist does not use it to the exclusion of the more fixed types or hesitate to use it in combination.

In my opinion some men are using the "lingual appliance" too extensively in its more simple forms, without adequate stabilization or combination with labial arch or labial spring loop attached to the lingual arch. Others are holding too blindly and arbitrarily to more complicated appliances in cases where the more simple lingual appliance would be the choice to the unbiased mind.

The most ardent followers of the lingual appliance must, if they would be successful, be so experienced in other technic; the pin and tube in its modifications, the ribbon arch, the expansion arch, and for retention when needed, the Hawley plates; as to employ them in combination with and to the exclusion of the lingual appliance in the cases when indicated.

The very so-called simplicity of the lingual appliance is a pitfall to the inexperienced or the overly busy orthodontist. As a straight line is more difficult to draw than a curve or

zigzag, so is the really successful use of the lingual appliance more difficult and its intelligent selection as the appliance to use and when to use in a given case, than is the use of an intricate appliance so cleverly conceived as to perform all tooth movements and hold them in more fixed retention.

It is my observation that the great majority of cases treated by the older orthodontists have some form of lingual appliance on at least one dental arch.

It is a significant fact that so many of Mershon's confreres agree in his conviction that the lingual appliance is indeed a most valuable means for applying orthodontic force as a means for stimulating development. The freedom allowed the teeth for physiologic movement in response to functional stresses when under pressure and during rest periods; its cleanliness and esthetic appearance are in my mind its main advantages. The infrequent changes necessary in the finger springs keep the force exerted in a more nearly uniform direction, which is also desirable for physiologic tooth movement. The rest periods advocated are excellent for reasons he gives and that growth is undoubtedly rhythmic, as evidenced not only in the mouth but throughout the body as a whole. The fact that but little retention is necessary in his cases is evidence that development has taken place. Conversely, cases needing retention show that development has not taken place during the active treatment. For the successful maintenance of the results obtained from treatment we must have normal metabolism and normal balance of function. Treatment to my mind is all that time occupied by what is usually termed treatment and retention.

Important as is an appliance in successful treatment, more important is the judgment and experience of the "man behind the gun." His correct selection of and correct use of the appliance used in a given case is the determining factor. He must have adequate knowledge of the tissues involved and broad understanding covering all phases of etiology, diagnosis, in fact, all contributing factors and treatment.

The orthodontist of well-rounded experience would obtain successful results by the use of any of several types of appliances and in selected cases, even without the use of any appliances. This last in my opinion is the most advanced technic because his treatment is the result of real diagnosis in that he understands the etiologic factors and eliminates them. His treatment being the building up of normal function of the associated tissues. A normal balance of function and all the forces concerned and related to the denture would be incompatable with malocclusion.

The most advanced orthodontist in treatment is surely the one who so well understands his cases as to most simply and apparently easily, if possible, without appliances as we know them, assist Nature to do her own great work of development.

In medicine we have seen the elimination of the wholesale medication of yesterday. The tomorrow of orthodontic treatment will be a further simplification rather than complication of appliances. Mershon, Rogers, Lourie and others glimpse this day and are leading us toward this goal.

I hope the discussion of this paper will not go into its mechanical aspects, but that it will continue along the broad biologic aspects that are so beautifully and forcefully presented by our essayist, and are so important for the successful use of not only the appliance he describes, but any appliance used in the practice of orthodontia.

Dr. P. G. Spencer, Waco, Texas.—With a limited immature experience, I feel somewhat presumptuous in attempting to discuss a paper evolved from a practical experience of many years, neither am I under the delusion that I am adding anything to that which you already know.

Any new presentation in any line of endeavor is skeptically received; greatly misrepresented, and without being understood, is generally condemned. Theories and practices, and teachings covering many years usually require an equal, or great length of time to be disproved. Orthodontic practices like the general practice of dentistry, has had the usual period of mysticism, ignorance, and mechanical specialization. The individual normal, whatever that is, cannot be measured anatomically by the yardstick. Dental arches are not built of brick or stone. We are dealing with living functioning cells. We can mold it only to the

extent of our material supply or to that which is available in that particular individual. We can throttle as well as stimulate the growth and developmental impulse.

Orthodontic appliances today are our greatest enemies. Diagnosis—the what, why, and where—is overlooked, in our desire to create.

The lingual appliance through theory and practice has accomplished more than any other single thing, in revolutionizing orthodontic study and thought. It is not the eternal perfection, and from experience I can state, that improperly handled, it is more "vicious than the male," and perforce receives therefrom its greatest condemnation; its mysteries are not unattainable perhaps, yet it is not mastered through a correspondence course. Like golf, it needs constant study and practice, and likewise it holds many pleasures in store for you.

To the practical side may I add that from my observation of lingual arch work with so many of us the difficulty lies in improper application of the auxiliary springs. Pressure, force, or stimulation to excess is the rule. Not so many years ago our patients visited us twice weekly to avoid that, a fixed attachment to every tooth under treatment was evolved, and mass movement, completed cases, or finished results were believed to be obtained in a few months. Mother Nature, in her present scheme of things, has found it best to utilize a period of six to eight years, and she produces a far superior product. I frankly believe that the least amount of force we are able to apply is, in 90 per cent of cases excessive, and for that reason, our "rest periods" are the most valuable parts of our treaments. Any impairment or restriction to function of any part while under treatment, even to a minor degree, is just that much at fault. The lingual appliance offers us the greatest assistance in prevention along that line.

I have heard papers read and discussions presented on the impossibility of obtaining root movement with a lingual arch auxiliary spring. Such discussions covering two-point contact, and fixed attachment to the teeth under treatment. The fact has been overlooked that when force (an objectionable word) from the auxiliary spring exceeds the counteraction from cheek and lips it is excessive, and also our two-point contact is obliterated. Realizing this emphasizes the meaning of gentle, limited stimulation, or eight to ten weeks' adjustment. Any immovable, or fixed attachment to a tooth under treatment cannot help but produce excessive stimulation, and thereby impair function. Ample evidence verifies this statement, if radiographs are made covering this method of treatment. I am of the opinion that if the evidence was available from such orthodontic treatment we would be appalled at the vast amount of root absorption.

As long as we have such variations of response or the many varieties of the individual normal, just so long will we be unable to standardize periods of treatment. We have frequently noticed distoocclusion cases under twelve years with lingual appliance treatment, which, following expansion, the mandible unassisted by elastics, voluntarily moves forward, or the incisors and premolars may be moved anteriorly with auxiliary springs, and the erupting second molar moved forward carrying the first molar to position, and an arch harmony is secured without elastics during a rest period. This procedure might not be possible with another child even in the same family.

Apparently unlimited designs may yet be found useful in auxiliary spring construction, providing we bear in mind that the combined reactions from the auxiliary springs must not exceed the resistance in our lingual arch.

It is an exceptional case in rotation or torsion that it is found necessary to band the tooth under treatment. The treatment of a number of such cases that are more frequently prevented was published in a recent issue of THE INTERNATIONAL JOURNAL OF ORTHODONTIA, ORAL SURGERY AND RADIOGRAPHY, desired stress being obtained by proper contouring and adaptation of the auxiliary spring.

In conclusion I cannot pass this opportunity of thanking Dr. Mershon for his many kindnesses to me, and any points I may have mentioned are simply a repetition of his ideas.

Dr. Herbert A. Pullen, Buffalo, N. Y.—Dr. Mershon has had a happy combination of experience, circumstances, and critical observation of the appliance and it enables him, as well as all of us, to enjoy the use of this appliance to check up on its limitations which he very generously admits.

I was pleased to hear him say that there was no universal appliance in orthodontic mechanism, for I have long held that opinion, but I do believe we have reached almost the maximum of perfection in the forms and adaptations of them.

The problem which confronts the orthodontist today is to select an appliance which will be efficient and yet, as Dr. Mershon has said, will aid and not interfere with the processes of natural growth.

The process of elimination of any of the appliances used in orthodontia will depend not so much on their lack of efficiency as upon the damage they may do to the alveolar tissues, the apices of the roots, or the tooth surfaces.

One of the most valuable points in the use of the lingual arch is its prophylactic superiority over any other appliance. It interferes the least with the natural changing action of the fluids of the mouth on the labial surfaces of the teeth and leaves the tongue as the natural toothbrush for the lingual surfaces.

I have appreciated reasonableness of Dr. Mershon in his presentation of the lingual arch and its combination and wish to compliment him.

Dr. F. M. Casto, Cleveland.—I want to add a word of commendation and appreciation to Dr. Mershon for his contribution to the progress and advancement of orthodontia through the development and use of the lingual arch.

Dr. Mershon (closing).—I want to thank the discussers for the very kind way in which they have approached my paper. I appreciate their sympathetic feeling in the matter.

PALAEONTOLOGY OF THE HUMAN DENTITION*

Part I. The Crown Patterns of Fossil and Recent Human Molar Teeth and Their Meaning†

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AND

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THE crown of a *second lower molar* (m_2 Fig 1A) of a white person is very apt to comprise four main elevations or cusps, grouped in two transverse pairs. Two of these cusps, which we will designate by the odd numbers 1, 3, are on the outer or cheek side, and the other two (2, 4) on the inner or tongue side. The outer cusps are more or less flattened, conical, the inner ones when unworn bear low cross crests. These four cusps are separated at their bases by two prominent grooves that cross each other almost at right angles near the middle of the crown: the longitudinal groove starts in front between cusps 1 and 2 and ends behind between cusps 3 and 4; the transverse groove begins well down on the outer side between cusps 1 and 3 and ends on the inner border between cusps 2 and 4. If these grooves were perfectly straight and completely at right angles to each other, all four of the main cusps would be in equal contact at the crossing place on the middle of the crown. But frequently cusps 1 and 4 crowd their neighbors a little and, gaining a small contact with each other, they prevent cusp 3 from being in contact with cusp 2. This whole arrangement of four cusps and two main grooves with the 1–4 contact has been called the "cruciform" or "plus-shaped" pattern of the lower molars.

In the first lower molar (m_1 Fig 1B) of all human races a fifth main cusp (5) is usually present behind 3 and nearer the midline of the crown. In this five-cusped type the simple plus-shaped pattern is replaced by a more complex arrangement, the most conspicuous feature being a more or less irregular Y, the stem of which is the inner transverse groove between cusps 2 and 4, the fork being formed by the outer half of the transverse groove (between cusps 1 and 3) and by the deep oblique furrow between cusps 3 and 5. There is no 1–4 contact but there is a prominent 2–3 contact. Near the front border of the crown between cusps 1 and 2 there is frequently a prominent transverse groove or crack which has been called the "fovea anterior" (f.a.), while on the hinder inner border, between cusps 5 and 4, a smaller fissure is called the "fovea posterior" (Fig. 1C, f.p.). This whole pattern of five main cusps,

*Read before the First International Orthodontic Congress, New York City, August 16-20, 1926.

†Reprinted from Natural History, Vol. xxvi, No. 3, 1926, pp. 300-309.

with the longitudinal and Y-shaped grooves, the 3–2 contact, the foveæ anterior and posterior, in 1916 was named by one of us the "*Dryopithecus* pattern" of the lower molars, for reasons that will appear later.

While there is a great variation both in the sizes and in the patterns of all the molars in modern races, the first molar is apt to be larger than the

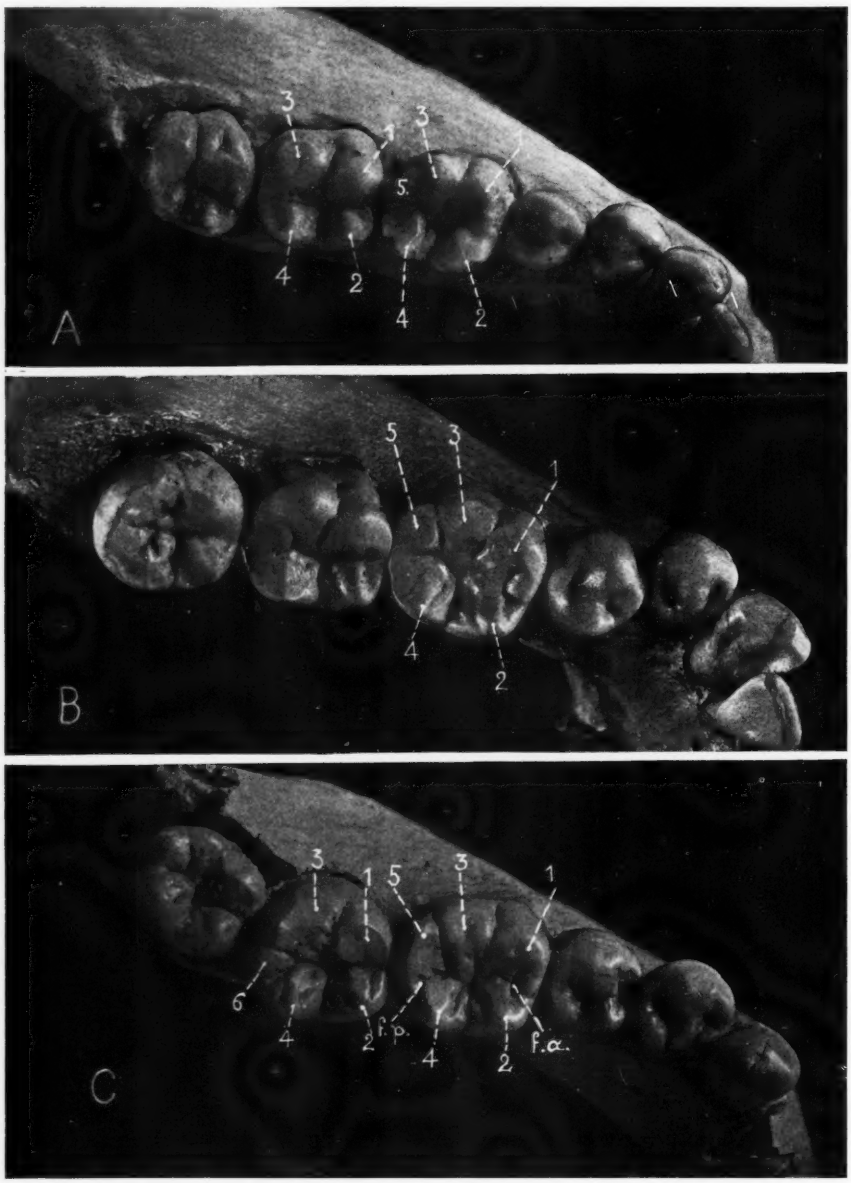

Fig. 1.—Human lower teeth, left side, showing arrangement of cusps in molars. *A*, White; *B, C,* Indian. Compare the arrangement of the cusps in the anthropoids (Fig. 2).

second, and it almost always tends to have five cusps and preserves more or less clearly the "*Dryopithecus* pattern" (Fig. 2). The second molar, especially in the white race (Fig. 1A) is apt to have only 4 cusps and the "plus pattern." The third molar, which is delayed in its eruption in the white race (Fig. 1A, m_3), is often smaller than m_1 and more or less irregular in outline,

usually with a 1–4 contact and irregular plus pattern. In Negroes the third lower molar usually erupts somewhat earlier in life; it is larger than in the whites and frequently retains five cusps and clearer traces of the "*Dryopithecus* pattern." With minor differences much the same conditions prevail in Australian aboriginals.

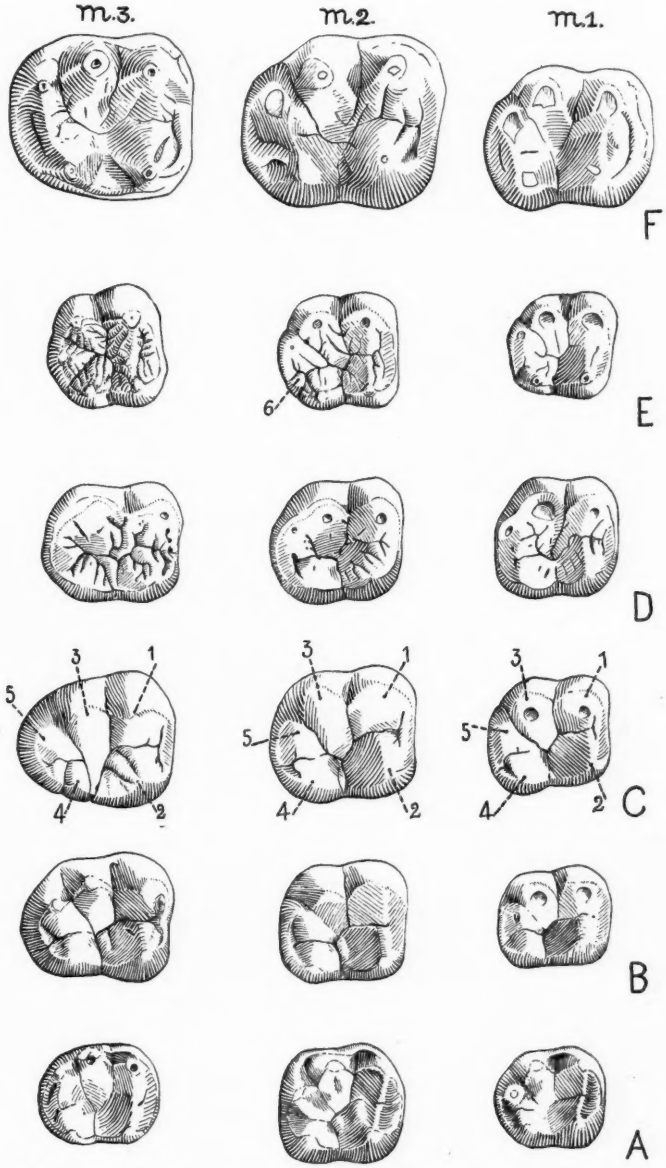

Fig. 2.—Left lower molar teeth of fossil and recent anthropoids. Drawing by Marcelle Roigneau.

F, recent gorilla, Africa; *E*, recent chimpanzee, Africa; *D*, recent orang-utan, Asia; *C*, *Dryopithecus frickae*, Miocene, India. *B*, *Dryopithecus cautleyi* from the Miocene of India. *A*. *Dryopithecus fontani* from the Miocene of France and Spain.

On all three molars of some races, such as Negroes, Australian aboriginals and Indians, a sixth cusp (Fig. 3D, 6) often appears on the middle of the hinder border and lying either between cusps 5 and 4 or in m_2 between 3 and 4.

In the later postglacial races of prehistoric men (Neolithic) the lower

molar teeth, while well developed, do not differ conspicuously from those of recent races, but in the older races from the Upper, Middle and Lower Pleistocene of Europe (Cro-Magnon, Grimaldi, Mousterian, Ehringsdorf, Heidelberg, Piltdown) the lower molars vary from a modernized condition in Cro-Magnon to a decidedly ape-like stage in Piltdown (Fig. 6). The lower

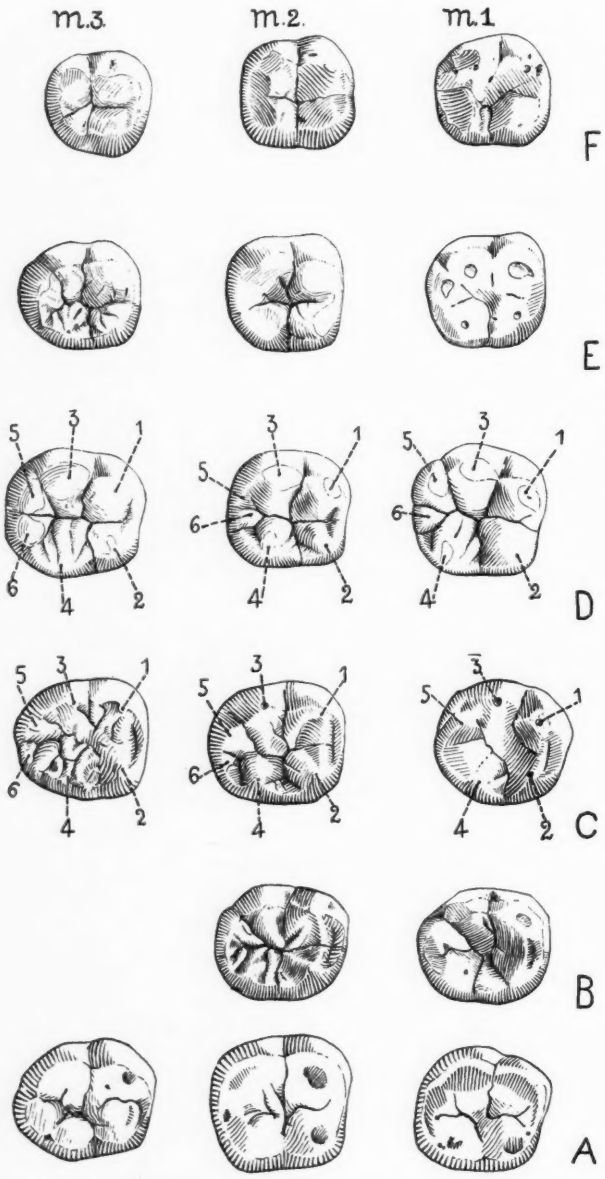

Fig. 3.—Left lower molar teeth of fossil and recent men. Drawing by Marcelle Roigneau.

F, White; *E*, Hindu, India; *D*, Australian aboriginal; *C*, Le Moustier (Neanderthal race); *B*, Ehringsdorf child (Neanderthal race); *A*, Heidelberg.

molars of the Javan *Pithecanthropus* are unknown, but to judge from the curious mixture of human and orang-like details in its upper molars,[1] the lower molars should also have been more or less ape-like.

[1]The evidence for this statement is given in Am. Mus. Bulletin, 1923, xlviii, 527-530. "Further Notes on the Molars of *Hesperopithecus* and of *Pithecanthropus*," by William K. Gregory and Milo Hellman.

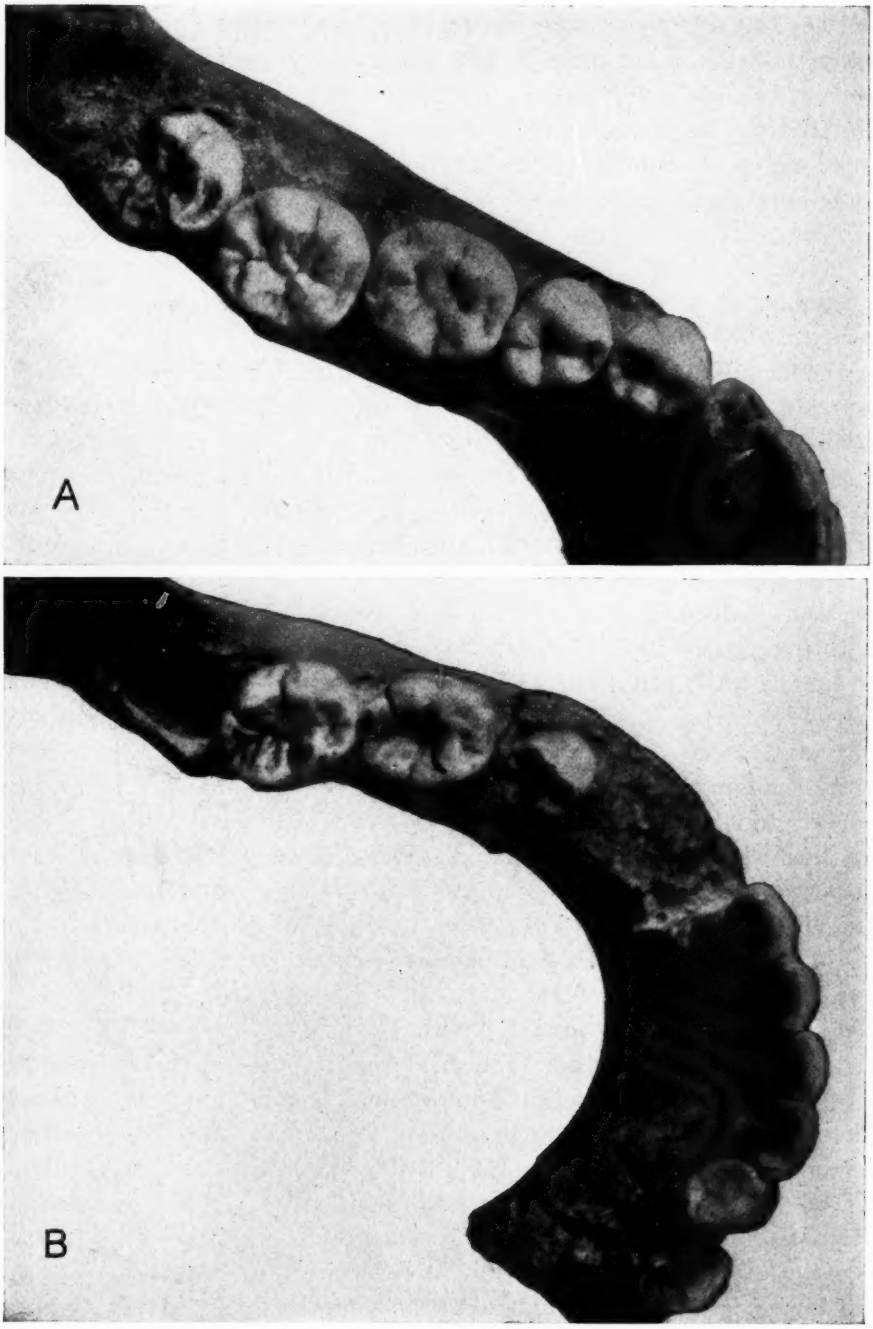

Fig. 4.—Fossil human lower jaws of the Neanderthal race. *A*. Le Moustier; *B*, Ehringsdorf child. Photographs by Professor J. H. McGregor.

The very ancient Heidelberg jaw from the First Interglacial stage of the Pleistocene epoch, in respect to its retreating chin and extremely wide ascending branch may fairly be termed ape-like;[1] but its dentition is definitely human, although retaining a few primitive features. Thus the five main cusps (Fig. 3A) are present on m_1, m_3, the *Dryopithecus* pattern is intact on m_1, there is a 3–2 contact on m_2. The left m_3 is reduced, with a plus pattern; the right m_3 is more primitive, with a 2–3 contact, with modified *Dryopithecus* pattern. To the palæontologist, possessing an intimate experience with the history of many mammalian lines during the Tertiary period, the fact that the Heidelberg teeth are definitely human while the jaw retains strongly ape-like features, can only mean that the first steps in the transformation of a generalized ape-like dentition toward the modernized human type must have taken place at a period far earlier than the Lower Pleistocene age of the Heidelberg man.

In the beautifully preserved dentition (Fig. 4A and 3C) of the famous "Mousterian youth" of the Neanderthal race, the crown patterns are more or less obscured by the development of fine secondary grooves and wrinkles rather suggestive of the conditions seen in certain chimpanzees and orangs as well as in the extinct ape *Dryopithecus rhenanus*. The modern plus pattern is conspicuously absent. On all three molars there are five main cusps, the 3–2 contact is undisturbed or emphasized, there are well developed foveæ anterior and posterior. A small cusp 6 is present on m_2, m_3. The third molar, just erupting at the time of death, has a prominent fovea anterior; the surface of the crown bears numerous secondary grooves and wrinkles.

In the "Ehringsdorf child" (Fig. 4B and 3B) the first molar crown is decidedly narrower in proportion to its length than is the case in typical modernized molars. The second molar is also relatively very long and narrow. Both molars have a very large conspicuous fovea anterior, a good 3–2 contact, a fovea posterior and an irregular Y-shaped groove. In the m_2 there is a small accessory transverse groove and ridge on the inner half of the crown between cusps 2 and 4. Exactly this combination of characters is found in certain lower molars of *Dryopithecus rhenanus* from the Pontian (Lower Pliocene) of Europe (Fig. 9D).

The famous Piltdown jaw[2] from the Lower Pleistocene of Sussex, England, is in general so ape-like (Fig. 5B) that certain authors, including one of us, formerly refused to admit that it belonged with the undoubtedly human, though in some points very primitive, Piltdown skull. But the discovery[3] of a second lot of fragments in the Piltdown gravels, consisting of a lower molar (Fig. 6B) closely resembling the first lower molar of the original specimen, associated with pieces of the forehead and occiput, appear to afford strong new evidence for Dr. Smith Woodward's original opinion that the ape-like lower jaw represents an extremely ancient and primitive species of mankind.

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[1]See the diagraph figures of ape and human jaws in plates XII, XIII, of Schoetensack's *Der Unterkiefer des Homo Heidelbergensis* . . . . Leipzig, 1908.

[2]See Dawson, C. and Woodward, A. S. 1913. "On the Discovery of a Palæolithic Skull and Mandible in a Flint-bearing Gravel overlying the Wealden (Hastings Beds) at Piltdown, Fletching (Sussex)," Quart. Journ. Geol. Soc., Vol. lxix, pp. 117-151, pls. xv-xxi.

[3]See Woodward, A. S. 1917. "Fourth Note on the Piltdown Gravel, with Evidence of a Second Skull of *Eoanthropus dawsoni*." Quart. Journ. Geol. Soc., Vol. lxxiii, pp. 1-10, Figs. 1, 2, pl. i.

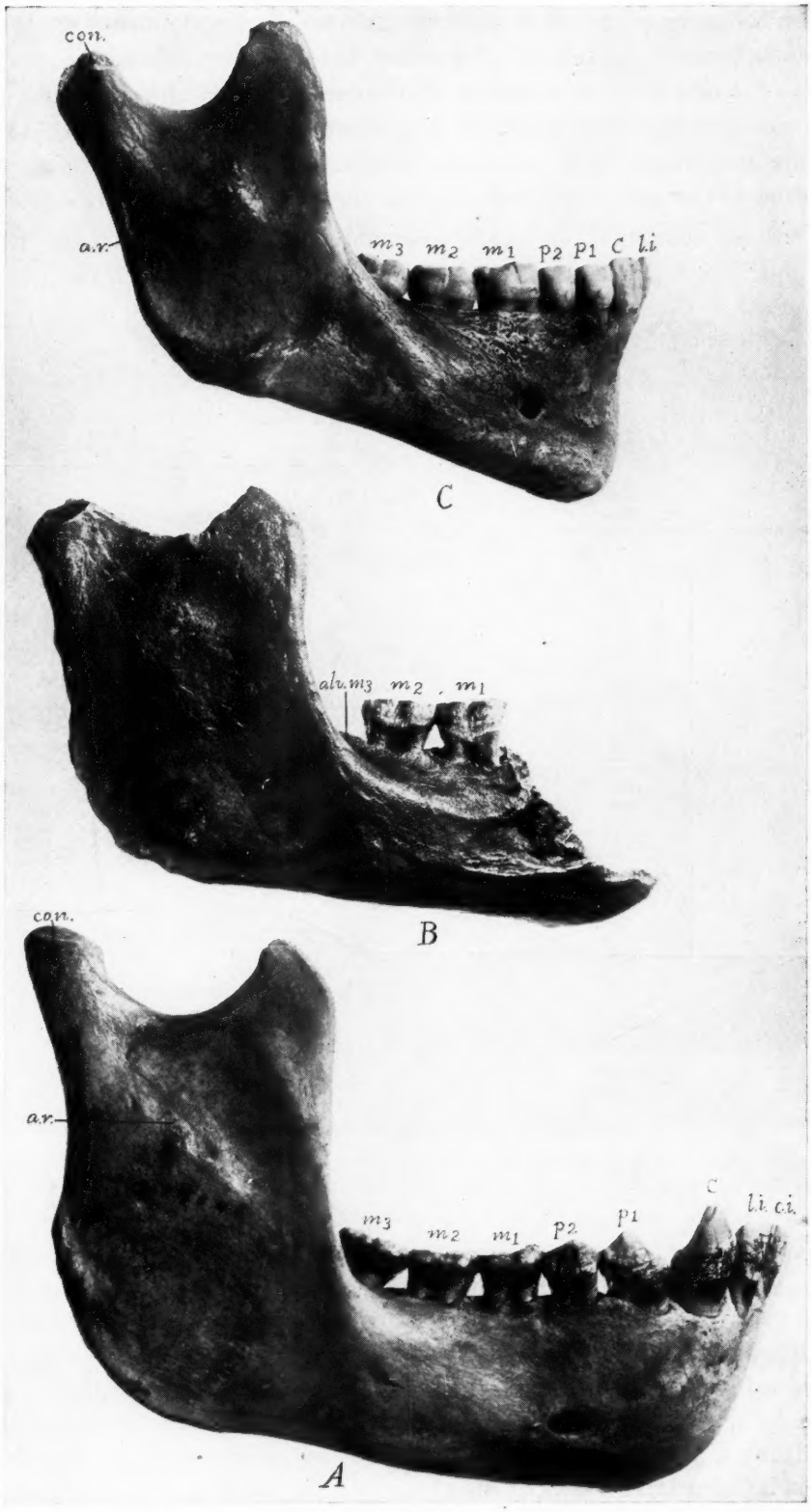

Fig. 5.—Lower jaws of orang-utan (*A*), Piltdown (*B*), and modern man (*C*).

What evidence do the crown patterns of the Piltdown lower molars yield on this interesting question? In both the original specimen and the later-found one (Fig. 6) the crown of the first lower molar shows the much worn surfaces of cusps 1, 3, 5, 2 and 4, and clear traces of the Y-shaped groove. Cusp 4 was not enlarged and is widely separated from cusp 1, the 3–2 contact being well established. Foveæ anterior and posterior are both present. The second lower molar is distinctly longer and larger than the first.

It will be seen that on the human side the conditions in the Piltdown lower molars are perhaps most nearly approached in the Ehringsdorf jaw. But in another direction the crown pattern of the Piltdown molars, as thus described, is identical with that of all the known species of the extinct apes named *Dryopithecus* and allied genera from the Miocene of Europe and of India. Here will be seen (Figs. 2, 7) the identical arrangement of five main cusps, Y-shaped groove, foveæ anterior and posterior, etc., to which the name

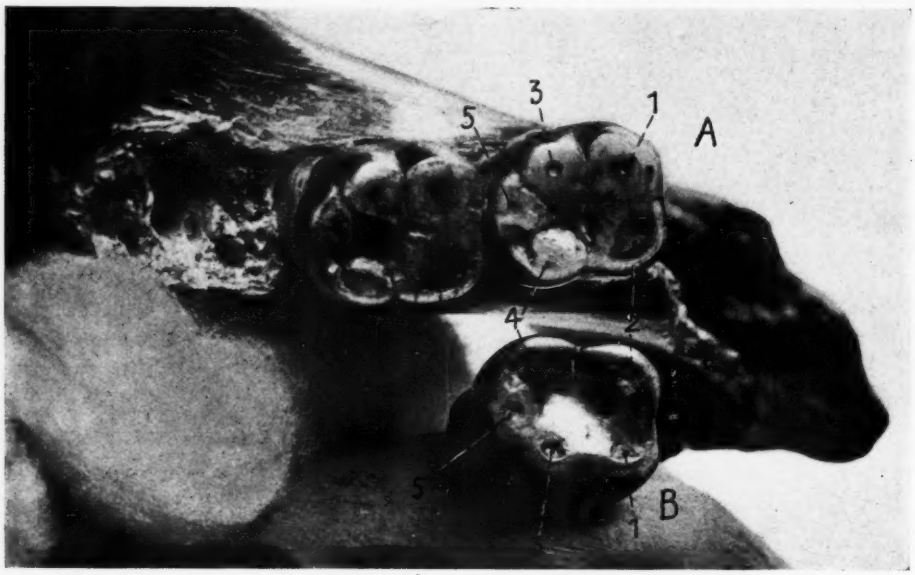

Fig. 6.—Lower molars of the Piltdown jaw, much worn but showing the pure "*Dryopithecus* Pattern." *A*, The first specimen; *B*, The second specimen. The photographs, by Professor J. H. McGregor, are reversed to facilitate comparison with Fig. 7.

"*Dryopithecus* pattern" was originally applied. Moreover, all the modern genera of anthropoid apes (Fig. 2) inherit this pattern intact but with diverse modifications.

What is the explanation of the fact that the *Dryopithecus* lower molar pattern, first foreshadowed in the very primitive gibbon-like genus *Propliopithecus* (Fig. 8B) of the Lower Oligocene of Egypt, flowers out during Miocene times in many specific forms in the wide-ranging fossil anthropoid apes of Europe, Asia, and Africa, is present in its completeness in the Lower Pleistocene Piltdown jaw, and becomes more or less obscured in the Heidelberg, Neanderthal and later races of man?

Why do the upper molars of the Mousterian youth (Fig. 9A, B) exhibit such an astonishing agreement in ground plan with the upper molars of

Dryopithecus rhenanus (Fig. 9C) from the Upper Miocene of Europe? And why are the second lower premolars of the Neanderthal and Ehringsdorf jaws most obviously composed of parts that are strictly comparable with those of the second lower premolar of *Dryopithecus?* (Figs. 4, 7.)

Why is it that in some chimpanzees the first lower premolar is a compressed, two-rooted tooth that retains much of the form of the corresponding tooth in the ancient *Dryopithecus,* while in some other chimpanzees the first lower premolar is a transversely widened single-rooted tooth that is strongly like a human first bicuspid? Why does the lower first premolar of *Pithe-*

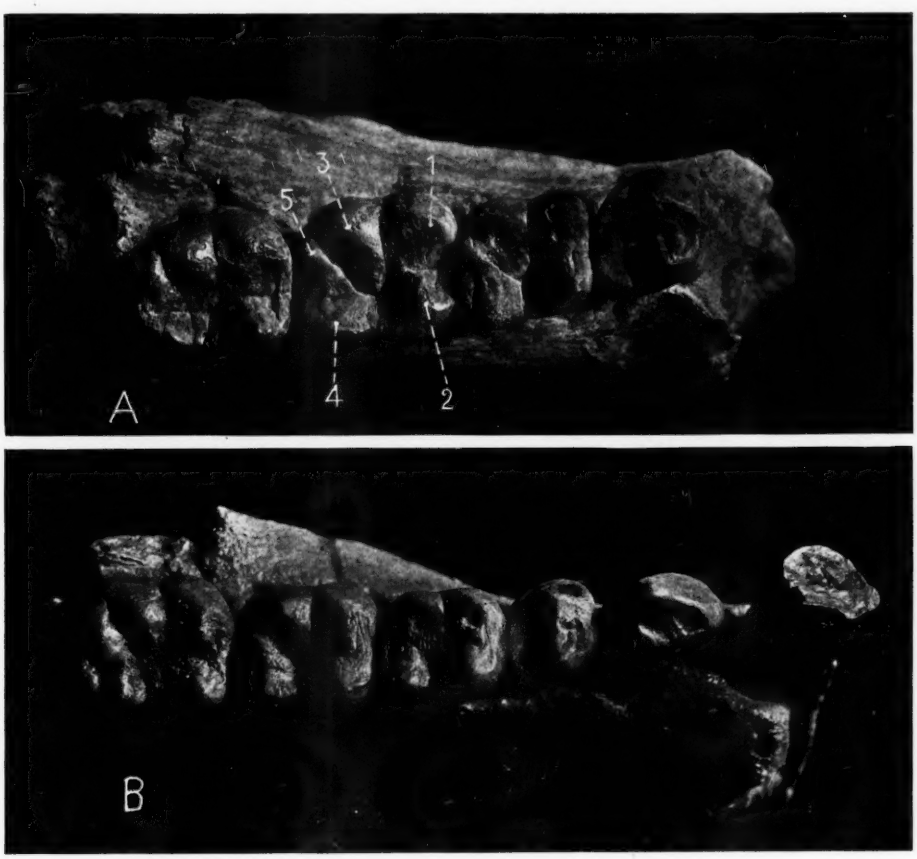

Fig. 7.—Left lower cheek teeth of fossil anthropoid *Dryopithecus.*—Collected by Barnum Brown, leader of the American Museum Expedition to the Siwaliks, India. *A, Dryopithecus frickae,* Miocene, India. X 3/2. *B, Dryopithecus cautleyi,* Miocene, India. X 3/2.

canthropus and of some Negroes and Australians retain two distinct roots, and why are these roots fused into one in modernized jaws?

Why is it that the canine tooth of the Piltdown jaw is essentially similar to that of *Dryopithecus?* Why are the lower incisors of the Mousterian and Ehringsdorf jaws comparable in fundamental characteristics of root and crown with those of modern gorillas?

Why are all the milk teeth of even modern man basically identical in their several patterns with those of corresponding teeth of modern anthropoids?

Why is the dental formula $I\frac{2}{2}$, $C\frac{1}{1}$, $Pm\frac{2}{2}$, $M\frac{3}{3}$ (meaning two incisors, one canine, two premolars, three molars on either side and in both upper and lower

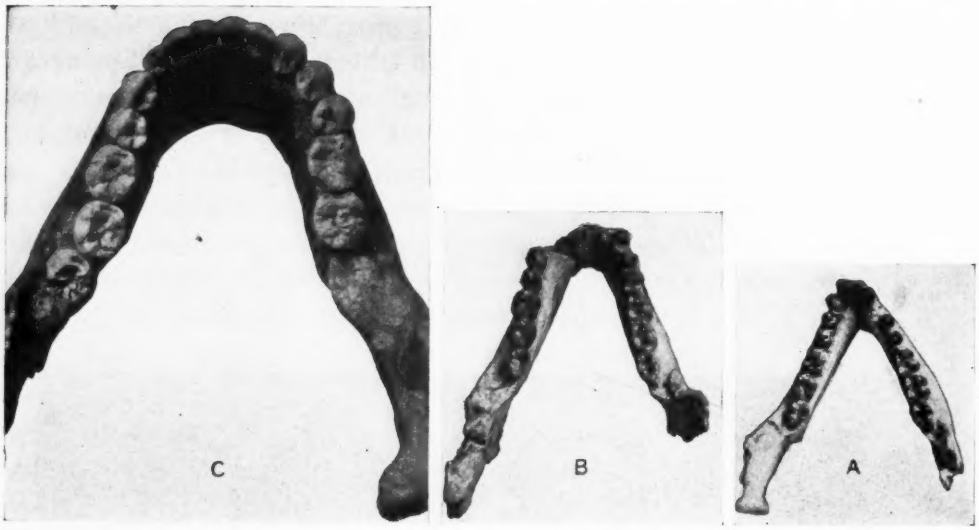

Fig. 8.—Three *structural* stages in the evolution of the human lower jaw. *A*, Primitive tarsoid stage (*Parapithecus*) with narrow space for the tip of the tongue and converging tooth rows. Lower Oligocene, Egypt; *B*, Primitive anthropoid stage (*Propliopithecus*) with nearly parallel tooth rows and wider space for the tongue. *C*, Primitive human stage (Le Moustier) with very wide space for the tongue and reduced and crowded front teeth. Photographs by Professor J. H. McGregor.

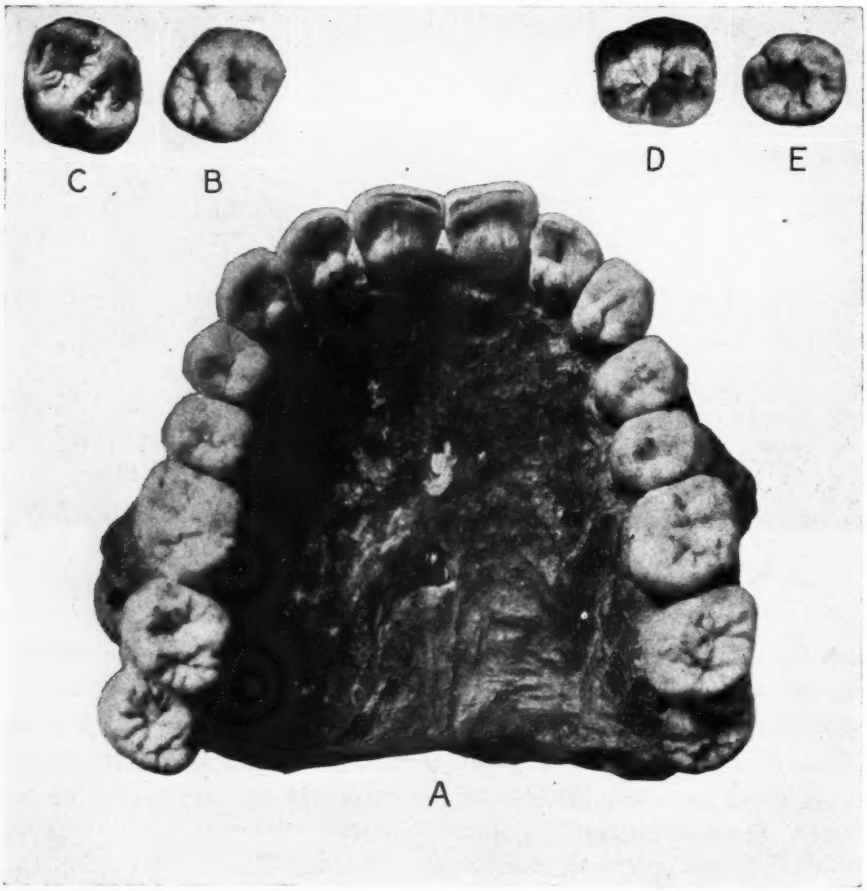

Fig. 9.—Anthropoid heritage in early human dentition.—Palate of Le Moustier (*A*). Comparison of second right upper molar of Le Moustier (*B*) with second left upper molar of fossil anthropoid *Dryopithecus rhenanus* (*C*). Comparison of first left lower molar of *Dryopithecus rhenanus* (*D*) with first left lower molar of Ehringsdorf child (*E*).

jaws) exactly the same in all fully developed normal adults dentures of men, anthropoid apes, and Old World monkeys?

And why are the dental formulæ different from this in all other groups of recent Primates?

Why is the formula for the milk teeth ($dI\frac{2}{2}$, $dC\frac{1}{1}$, $dP\frac{2}{2}$) also the same in all human races, in all anthropoid apes, and all Old World monkeys?

All these and a thousand similar questions might fairly be put to those who, ignoring the convergent evidence of comparative anatomy, physiology and psychology, mammalogy, palæontology, and the like, persistently denounce as untrue Darwin's inference that man and the modern anthropoids, in spite of widely divergent specializations, have inherited their innumerable structural and physiologic correspondences from some very primitive and early member of the anthropoid group of Old World Primates.

PALAEONTOLOGY OF THE HUMAN DENTITION

Part II. Ten Structural Stages in the Evolution of the Cheek Teeth

By William K. Gregory, New York City

INTRODUCTION

THE human upper and lower jaws in normal occlusion are part of a mechanism, the wonder and beauty of which are nowhere more fully appreciated than by the members of this Congress. Were these complex relations of upper and lower cusps and surfaces created perfect, at one stroke, have they always been as we now find them, or have they attained their present status after a long and gradual series of modifications from more simple beginnings? And how far, in the present imperfect state of our knowledge, can we begin to discern an orderly succession of stages in the evolution of the dental apparatus?

Since the evolution of the orthodontic relations of the human upper and lower teeth is thus clearly a phase of the general study of the evolution of man, it may be fortunate for me that I can say what I have to say now, before a new constitutional amendment makes the whole topic legally taboo and our next Congress in this country subject to closure by agents of the Federal Government. At least in New York at the present time it is still reasonably safe to lecture in public on the evolution of man, but all over this broad land fiery zealots, with the energy of the Hebrew prophets, are calling upon their followers to throw down the idols of the evolutionists. Thundering into loud speakers from a thousand pulpits, they brand the scientific doctrine of the evolution of man as a flimsy hypothesis. Professing their desire to purge and purify true science, they denounce as "pseudoscientists" all university professors and laboratory workers who dare to teach anything contrary to the traditional belief that Adam was literally made out of the dust of the ground and Eve from one of Adam's ribs.

But it is vain for them to "kick against the pricks." They may make it illegal to teach evolution in state-supported universities, colleges, and schools, but they cannot stop the endless discoveries of facts that have made the gradual evolution of the body and mind of man one of the most reasonable and fully documented inferences in the whole field of the biologic sciences.

The radio orators naturally feel no embarrassing doubts as to their own competence to dispose of the subject of the evolution of man after they have read a few popular works on the subject and have got hold of a few citations of so-called authorities who have expressed opinions supposed to be damaging to this or that point of the evolutionist's argument. The scientist, however, is necessarily more modest. He realizes that thousands of important details of the story of human evolution must ever remain in doubt, and that at the present time science has reached no brief, clear-cut picture as to the general mechanism of evolution, that is, the precise manner in which Natural Selection, the Environment, and other factors finally overcome the conservative

forces of heredity and induce a definite shift from one structural level to the next. The scientist, moreover, recognizes that there is no royal road to a first-hand knowledge of the broader aspects of the origin and evolution of man. He perceives that the evolution of man is only a special case of the evolution of animals in general, and so he must first labor unceasingly to disentangle and classify the myriad twigs and branches of the great tree of verebrate life. Fortunately a small army of investigators, namely, students of systematic zoology, comparative anatomy, and palaeontology, have long been fruitfully engaged in this field. Thousands of studies in the anatomy and classification of recent and extinct vertebrates, all quite unknown to the pulpit and public press, have supplied the outlines of a tolerably detailed picture of the main branches and twigs of vertebrate life and of the principal stages in the ascent from fish to man. From a wide synthesis of such studies it has been learned that the evolution of the vertebrates may be sketched under the following heads: first, the successive changes in the locomotor apparatus; secondly, the evolution of the respiratory, vascular, and alimentary systems, the last including the masticatory apparatus; third, the evolution of the reproductive organs and methods; fourth, the evolution of the coordinating organs of the peripheral and central nervous systems.

Scores of millions of years ago in Devonian times we meet the relatives and forerunners of the fishes with limbs and lungs, the hardy pioneers that first struggled up out of the water on to the land. Next, in the time of the Coal Measures, we find both the varied amphibians not yet wholly freed from the water and the earliest common ancestors of the reptiles and of all higher types. Coming on to the Permian and Triassic ages, each many millions of years in duration, we encounter several grades of organization among the mammal-like reptiles—and some of these almost deserve to be called pro-mammals, so progressive are they in locomotor and masticatory apparatus. Proceeding to the Jurassic ages we come upon true mammals, with the beginnings of the tritubercular type of molar teeth; and quite recently Cretaceous placental mammals have been discovered in Mongolia, which, as we shall see, supply a long-needed link in the evolution of the molars. Passing to the Lower Eocene we find early representatives of that great order, the Primates, which was destined eventually to give rise to man, and which even at that far-distant epoch was already distinguished by its superior development of eye, and hand, and brain. In the Lower Oligocene of Egypt we meet the first ancestors of the branch which was later to subdivide into the anthropoid apes on the one hand and the races of man on the other, and in the Miocene we encounter traces of various true anthropoids, among which are some that, according to my interpretation of the evidence, stand in or quite near to the common stem of man and the modern anthropoids. In the Lower Pliocene our anatomic records, apart from one or two debatable finds, are a blank, but in the Pleistocene we have in gradually ascending levels, first, the *Pithecanthropus,* a mature man although in a low stage of development; secondly, the Dawn Man or *Eoanthropus* of England; thirdly, the Heidelberg man; fourthly, the Neanderthal man, and finally the Cro-Magnon, true *Homo sapiens,* and his successors of the late Palaeolithic, Neolithic, Copper, Bronze, and Iron ages.

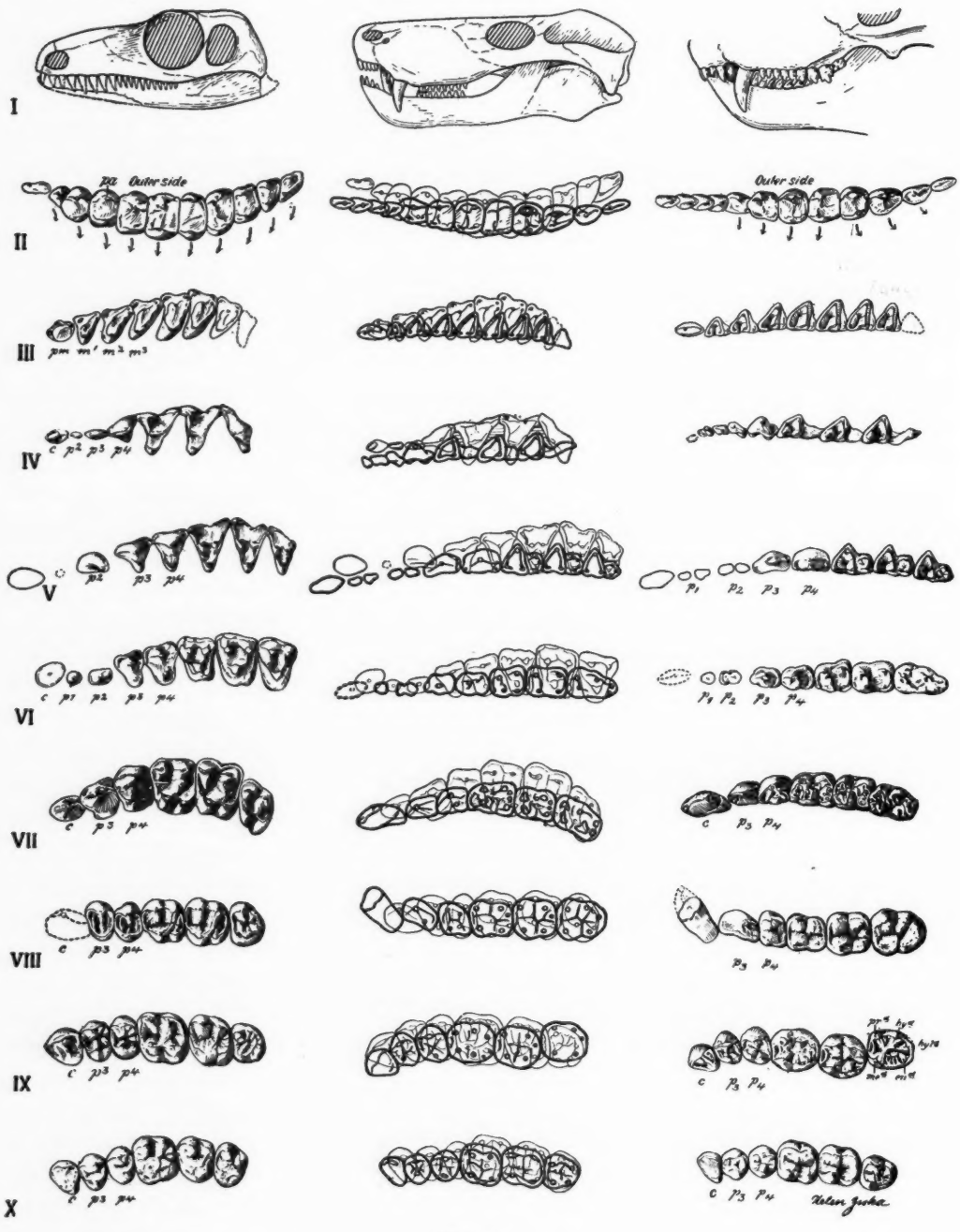

Fig. 10.

I. Substage *a.* Permo-Carboniferous. *Mycterosaurus,* primitive Theromorph Reptile. After Williston.
Substage *b.* Permian. *Scylacosaurus,* primitive Mammal-like Reptile. After Broom.
Substage *c.* Triassic. *Cynognathus,* advanced Mammal-like Reptile. After Seeley.
II. Triassic. *Diademodon,* advanced Mammal-like Reptile. Mainly after Seeley. Occlusion diagram by author.
III. Jurassic. Pantotherian (primitive pro-Placental). Kindness of Dr. G. G. Simpson. Occlusion diagram by Simpson.
IV. Cretaceous. Pre-Tituberculate, *Deltatheridium.* From the original specimen. Occlusion diagram by author.
V. Lower Eocene. Primitive Placental, *Didelphodus.* From the original specimen. Occlusion diagram by author.
VI. Middle Eocene. Primitive Primate, *Pronycticebus.* After Grandidier. Occlusion diagram by author.
VII. Upper Eocene. Advanced Tarsoid Primate, *Microchoerus.* After Stehlin. Occlusion diagram by author.
VIII. Miocene. Primitive Anthropoid Primate, *Dryopithecus.* Upper molars mainly after Pilgrim; lower molars from type of *Dryopithecus cautleyi.* Occlusion diagram by author and Milo Hellman.

At each stage of this long line of ascent we must analyze the known osteologic and dental characters and endeavor to discover what forms lie in or near the line of human descent and which ones are leading off in various directions to the specialized sidelines.

The ten structural stages in the evolution of the human cheek teeth described above are all represented by known forms, extending in time through ascending geologic horizons from the Permo-Carboniferous to the Recent. Not one of them is in any sense hypothetical. The drawings depicting the verifiable facts of observation have been made with the most painstaking care by a skilled artist, Mrs. Helen Ziska, under my close and constant supervision.

The succeeding stages are so clearly indicated in the figures as hardly to need verbal description.

SUMMARY AND CONCLUSIONS

Unfortunately the detailed labors of palaeontologists and of students of the major classification and evolution of the mammals are so little known to most of their own colleagues in other branches of the biologic sciences, that few can realize from first-hand knowledge that the study of the evolution of human molar teeth is no longer in the vague stage of fog and uncertainty. The cumulative and ever widening evidence for Darwin's view that man is an off-shoot from the base of the anthropoid stem securely links the study of the evolution of human cheek teeth with the history of dental evolution in the infrahuman primates. And here we have clear documentary evidence, resting on no hypothetical stages, that enables us to follow the patterns of the human dentition backward to the Dryopithecus stage, thence to the primitive Primates of the Eocene, the dentition of which in turn closely approaches those of many other Eocene phyla that sprang from the central tuberculosectorial Placentals of Basal Eocene times. The discovery of definitely pretritubercular placental mammals in the Cretaceous of Mongolia carries the history backward to a point near or at the origin of the "stem Placental" mammals, long expected but never hitherto known from fossil specimens. Back of this the long gap to the very beginnings of the future tritubercular stock in the Lower Jurassic age still remains to be explored in detail, but even from present evidence little doubt can remain that the relation of reversed triangles between the upper and lower molars was not arrived at by the steps inferred by Cope and Osborn but took the general course inferred in outline by Wortman and several subsequent authors. The known Jurassic Pantotherian mammals again are advanced far beyond the most advanced mammal-like reptiles of the Triassic age, but these in many respects are nearer in structure to the mammals than they are to the stem reptiles of the Permo-Carboniferous. Among the latter, *Seymouria* again

IX. Pleistocene. Primitive Man, Mousterian. From stereoscopic photographs by Professor J. H. McGregor and from the published photographs by Weinert and by Virchow (m_3). Occlusion diagram by author.
X. Recent. Modern Man, White. From the original specimen. Occlusion diagram by author.

divides the difference between the most primitive amphibians and the typical reptiles, while there is the strongest morphologic and palaeontologic evidence for connecting the amphibians with some undiscovered group of air-breathing fishes related both to the Fringe-finned Ganoids and the Dipnoans. Reading the story the other way, the ten structural stages in the evolution of the human cheek teeth, as described in the present paper, may be summarized as follows:

I. Substage *a*. Permo-Carboniferous. *Mycterosaurus,* primitive Theromorph Reptile.
Substage *b*. Permian. *Scylacosaurus,* primitive Mammal-like Reptile.
Substage *c*. Triassic. *Cynognathus,* advanced Mammal-like Reptile.
II. Triassic. *Diademodon,* advanced Mammal-like Reptile.
III. Jurassic. Pantotherian (primitive pro-Placental).
IV. Cretaceous. Pre-tritubercular, *Deltatheridium.*
V. Lower Eocene. Primitive Placental, *Didelphodus.*
VI. Middle Eocene. Primitive Primate, *Pronycticebus.*
VII. Upper Eocene. Advanced Tarsioid Primate, *Microchoerus.*
VIII. Miocene. Primitive Anthropoid Primate, *Dryopithecus.*
IX. Pleistocene. Primitive Man, Mousterian.
X. Recent. Modern Man, White.

THE PLACE OF EXTRACTION IN ORTHODONTIC TREATMENT*

By J. D. Badcock, London, England

TO SOME here today the title of my paper may seem a contradiction in terms, born of reaction and begotten of ignorance.

Extraction, they may say, is the negation of true orthodontia, and has no place therein, but I venture to think that such objectors, will be far fewer today than they would have been ten years ago, fewer still perhaps than twenty years ago, when "normal occlusion" was still almost universally preached as the "be all" and "end all" of our art.

It is nearly forty years since Angle published the first edition of his book emphasizing the significance and importance of normal occlusion, and gave to the world his classification based thereon, imperfect no doubt; but its promulgation marked an epoch, laid the foundation of scientific treatment, and evolved order from chaos.

There had been, and were, many other workers in the field; but it was Angle's insistence on occlusion, as the keynote of diagnosis and treatment, that wove a pattern of the scattered threads, and gave the impetus to the practice of orthodontics which started it on a course of progress which increases year by year.

He taught that the restoration of normal occlusion was the only worthy object of the orthodontist's endeavor, that harmony of feature was impossible without it, and believed that this end could always be obtained if only the right means were employed. Extraction he stigmatized as mutilation.

His teaching was received with enthusiasm, and put to the test by a large band of followers.

As the years have passed enthusiasm has been tempered by experience, and the increase of knowledge has confirmed its lessons.

It is now realized that, while the highest perfection cannot be reached without normal occlusion of the thirty-two teeth, there are often limitations which make this ideal unattainable, and something less all that can be hoped for or achieved.

Extraction in some form or other, at some time or other, is coming to be recognized on all sides as a necessary factor in orthodontics.

What is the ultimate aim of our specialty? Surely it is the attainment of good function and good appearance, utility and beauty, and further, the attainment of these aims by methods the simplest and the most certain, involving the patient in the least discomfort, trouble and expense, but securing for him the best result possible under his particular circumstances.

This may be, but is not necessarily, synonymous with the arrangement of the thirty-two teeth in perfect occlusion, indeed that ideal has often been

*Read before the First International Orthodontic Congress, New York City, August 16-20, 1926.

made a fetish to which the welfare, the pocket, and even the appearance of the patient have all been sacrificed. Today we must take a broader view.

We used to try to explain the various forms of malocclusion on mechanical grounds, by the inharmonious action of various forces on growing bones, the pressure of the lips, the tongue, lateral pressure of the cheeks of the mouth breather, negative pressure in the nose, lack of functional activity, and so forth, all causes acting after birth.

Now we know that, putting aside irregularities which may be called accidental, such as those due to habit (e.g., thumb-sucking), or to the non-development, or premature loss of certain teeth, a large class of the irregularities with which we have to deal is due to deficient growth of the jaws, and correlated bones, and that the ultimate causes of this condition must be looked for much deeper, and much further back in the life history of the individual than we have been accustomed to seek them, many and the most serious, even as far back as the germ plasm itself; in disturbances of those influences governing growth, of whose existence we are beginning to learn, but know so little yet.

In proportion as these causes are revealed treatment must become less empirical and more rational and effective.

With suitable appliances we can mould alveolar bone, we can even stimulate its growth up to a point, but to influence the growth of the bony foundations of the alveolar arches by mechanical means I believe to be impossible in the present state of knowledge.

The only chance of doing so would appear to be by measures which favor healthy growth in general, food of the right kind, light, fresh air, and good environment, with full functional activity. The earlier the treatment, the better the result. What success might be expected at an age at which such cases are likely to come under observation must be conjectural. It would seem that any such treatment must be preventive rather than curative; though the administration of extracts of ductless glands, when we have more definite knowledge of their action, appears to offer some hope.

With the advance of civilization, and the softer food that has accompanied it, human jaws are becoming smaller, often without corresponding diminution in the size of the teeth. How is Nature meeting the case? She is gradually reducing the number of teeth. Sometimes she withholds the upper lateral incisors, sometimes third molars, sometimes premolars, so we may fairly argue that to remove teeth from too crowded jaws in certain cases is no outrage, but rather a following of Nature's lead.

To attempt to arrange the thirty-two teeth in normal occlusion is to court failure in cases where the basal growth is seriously subnormal. We may achieve a result which appears reasonably satisfactory at the time; but the tendency to relapse will be very great; pressure of the wisdom teeth will increase this, and, if these are able to erupt at all, they will most certainly do so in faulty positions.

In such cases removal from the series of appropriate teeth, so harmonizing the coronal and apical curves of Lundström, appears to be the only rational procedure; it will allow of the much easier arrangement of those which remain, will lessen or remove the risk of relapse, and make the cor-

rect eruption of the wisdom teeth more probable. Normal occlusion will not be restored, but the result will be functionally and esthetically satisfactory.

A number of cases have been reported by Dr. Varney E. Barnes in a paper entitled "A Study of Third Molar Impaction Associated with Orthodontic Retention," where the extraction of third or second molars becomes necessary to stabilize the occlusion, and such cases must be very common.

That long, difficult and tedious regulation should culminate in what is frequently a serious surgical operation is surely wrong. Might not such a catastrophe often be prevented by judicious extraction at an earlier age?

Permanence of result is of the utmost importance and the measure of its probability must be borne in mind from the first. How often is it secured? What is the percentage of relapse?

Mr. Lockett raised this question in a paper read before the E. O. S. in London last winter, and it would be very interesting to know the answer.

It is a matter of common experience that expansion undertaken after the period of full eruption of the premolars is very liable to relapse, however successful the immediate result may have appeared, illustrating Northcroft's statement that mechanical stimulus is of little avail once the physiologic period of growth has passed.

Often patients come to us for the first time at twelve or fifteen years of age, when appearance is just beginning to be of importance, or even later still; frequently they have been treated already and relapsed. Here again extraction has its place; by its means an enormous improvement may often be effected with the certainty that it will be permanent, and that without the use of retention apparatus for long periods.

Analogous in their results to cases of crowding due to insufficient growth of the jaw proper are those where crowding is due to forward movement of permanent teeth, owing to premature loss of deciduous teeth. Of these the best example is afforded by the forward movement of first molars due to the premature loss of second temporary molars with the resultant crowding out of the second premolars.

If caught early the first molars may be tilted back again into their correct positions, and space restored for the incoming premolars; but if correction be delayed until the second and perhaps third molars have also moved forward the only choice lies between reducing the number of the teeth or bringing the whole series into an abnormally forward position. Here again extraction would appear the only logical course.

Where teeth are missing from the series by reason either of nondevelopment, or extraction, the choice often, though by no means always, lies between the adaptation of some prosthetic apparatus to fill the space, and allowing the space to close and extracting one or more teeth, not necessarily the corresponding teeth, from the other jaw, so attaining some measure of correlation of the arches.

Opinions will differ as to which is the better method. My own view is that a natural denture, even if two or three teeth short, is, in a young mouth, infinitely to be preferred to a restoration to be worn throughout life, with all its potential trouble, danger, and expense.

Example: Absence of the upper laterals with resultant spacing. Extraction of one or more lower incisors will allow the teeth to fall back and the spaces to close. There will be slight flattening of the arches but to an extent not noticeable by the layman.

So far I have dealt with some of the physiologic reasons for extraction; but orthodontic treatment has its economic as well as its scientific side, and expediency must often govern practice.

Not the result only, but the cost has to be considered, cost in time, stress, and money.

The specialist is always prone to take a narrow outlook, and to magnify the importance of his own specialty.

There is a temptation to regard the patient merely as a medium for the highest expression of his art, as the painter regards his colors, or the sculptor his clay, and to lose sight of the fact that his particular work does not represent the whole sum of the patient's welfare but only one factor therein, and that something which falls short of his ideal may be the best for his patient, if it shortens the treatment, or diminishes the stress, or reduces the cost, any or all as the case may be.

The choice of treatment in any particular case should take into account many factors relating, not only to the patient, but to his environment. Among them are: Family characteristics; build; age; temperament; health; parents and guardians; length of purse; accessibility; availibility of means of treatment.

An abnormality may be so characteristic of a family type as to be considered normal for that family, and in such a case, unless it is very unsightly or really harmful, it might be better to leave it uncorrected.

The build of the child is important, and one's line of treatment may often depend upon the opinion formed of his or her probable growth, as judged from the size in relation to age, height, size of hands and feet, stature of parents, etc. The modern orthodontist should weigh and measure his patients.

Age is extremely important. While it is easy to mould the jaws at seven or eight years old, or younger, with every probability of achieving a permanent result, it is very different four or five years later, and the risk of relapse is then very serious.

It is quite useless to attempt elaborate measures for a child who will not try to carry out instructions, or who is definitely antagonistic, and it is equally hopeless if the parents are lukewarm, or entirely careless, allowing anything and everything else to take precedence of teeth. Such a case will end in failure, and the blame will certainly be put upon the orthodontist. One should therefore make very sure before beginning a lengthy treatment that the parents are prepared to see it through to the end.

To children with excitable or unstable nervous systems the wearing of any apparatus may be harmful. I believe this to be rarely the case if its use is painless, as it should be; but such cases do occur and the point must be taken into consideration.

Expense, the ability of the patient to pay the necessary visits, and to come at once when anything goes wrong, and the availability within the patient's

reach of a dentist able to carry out elaborate technic can none of them be ignored.

I am told that, whereas the great majority of the children of the upper and middle classes in Great Britain are educated at boarding schools, such is not the case in U. S. A.; and that they can drop in on the dentist on their way from school as often as he may desire. If this is so, methods of treatment there and here must necessarily often differ.

It is evident that we must cut our coat according to our cloth, and I think it is unfortunate that advanced orthodontists should so often discourage the use of the simpler remedial methods, the only possible methods in very many cases. Surely treatment falling short of perfection is better than none at all, and that treatment is the best for the individual case, which has regard to all its conditions.

I often wonder what becomes of American children in places where there is no orthodontist, or who cannot afford his services where there is one; perhaps in this great country there are no such places and no such children. That is certainly not the case in Europe. There extraction must enter largely into the treatment of the great majority of children for whom any treatment at all is feasible.

We must not forget that orthodontics is a science of world-wide application and that its benefits should not be the monopoly of the wealthy class. In its simpler forms, at least, it should be available for all.

Too little attention has been given to scientific extraction. We have still much to learn as to the conditions which demand it, the age to adopt it, and which teeth to extract in order to arrive at the results we wish to obtain.

To sum up. While the highest aim of the orthodontist should be the preservation of the thirty-two teeth in normal occlusion it is an ideal which cannot always be attained, nor is its attainment always worth the sacrifices it may entail.

There are large classes of cases where for various reasons, physiologic, psychologic, or economic, extraction alone or in combination with other measures offers the only hope of even moderate success.

If extraction is sometimes the *best* treatment, if often, though not ideally the best, it will so simplify treatment as to make it available, though in lesser perfection, for large numbers who would otherwise have to go untreated, surely it has its place, and a very important place in our practice. It must no longer be banned as "mutilation," but recognized as an indispensable aid, and inasmuch as nothing is more disastrous in its results when ignorantly or injudiciously performed, the principles which govern its practice should be understood by every orthodontist, and studied and taught in every orthodontic school.

In conclusion perhaps I may enquire, with Bishop Berkeley, "whether one whose end is to make his fellowmen think may not gain his end, even though they should not think as he doth?"

DISCUSSION

Dr. Albert W. Crosby, New Haven, Conn.—Our distinguished visitor divides his paper into two parts which he designates as the physiologic and the economical aspects of the question he raises for debate and on which he takes the affirmative.

If I interpret correctly the attitude of the majority of those who practice orthodontia exclusively, in this country we feel that extraction has a very small part in treatment. There are, of course, diseased teeth which are a menace to the health which have to be reluctantly sacrificed. The consideration of such teeth I should not place strictly within the scope of this paper. Aside from these teeth there are impacted third molars which not only interfere with the successful retention of the teeth but are often the source of serious reflexes, such as neuralgia, often accompanied by grinding of the teeth at night and sometimes by lack of power of concentration.

Very small peg lateral incisors, too small to support a jacket crown, may be another instance, but beyond these there are few cases, I am sure, where we are warranted in extracting teeth in orthodontic treatment for growing children.

Orthodontia as a specialty is little more than a quarter of a century old. Prior to 1900 there were not three men in the whole world who were practicing orthodontia exclusively. If my information is correct there are no more doing so exclusively in Great Britain at the present time. Our knowledge of the etiology of malocclusions is not yet very well advanced.

The question of habits, which is receiving a good deal of attention at present seems to me to have a great deal more in it than his paper suggests. Of course, we cannot retain our corrected cases if we do not get rid of the cause of the trouble. To give only three examples of habits which have come forcibly to my attention; I can assert, with some confidence, that many of the cases of Class II, div. I, sub. div. (Angle classification) are the result of habitually leaning the chin on the hand and in turn the elbow on the arm of the chair or table while reading or studying. To my mind this explains why so many of these cases take so long to treat with the intermaxillaries and are so difficult to retain. Of course it would be easier to extract the first bicuspid and let the misplaced cuspid come into line but the easiest way is seldom the right way.

The same position but with the knuckles resting in the cheek will make the upper arch concave on the side where this pressure comes habitually, often with one or more of the buccal teeth forced into lingual occlusion and with its persistence a well-rounded arch cannot be retained. Lying on the stomach, especially if the hands are under the pillow, brings considerable pressure on the cheeks and is bound to produce a narrow pointed arch. Dr. Harvey Stallard has called attention to a number of faulty sleeping postures and illustrated their baneful results.

My reason for mentioning habits is because I think Dr. Badcock is inclined to give them scant attention. If I interpret our position correctly extraction is at best a makeshift and an acknowledgment that we do not understand etiology.

Heredity undoubtedly has some bearing on faulty and insufficient facial development. It may take three generations to get good development naturally as Dr. McCullum says it takes three generations to produce good teeth. If this is so, the sooner we begin the program of education the better. If we do not see the children before the permanent teeth are in there is something wrong about dental education. It is our duty to do so as much as we can to further knowledge of the desirability of early treatment, always having in mind that what satisfies this generation will not be acceptable to a better educated next generation.

Some of us are now working on the second generation and are also asked for advice by mothers of children we are treating who have other younger ones coming on. We are frequently asked, "What can I do to prevent my baby having to wear appliances?" One of the best things we can say is to have them come in as soon as the temporary dentition is complete and arrange to see them every six months. This gives opportunity to give good advice and keeping the mothers up to the point of enforcing it as a regular routine. But before this the mother should be taught that as soon as the baby has teeth, hard food should be introduced, and as Dr. Bogue some years ago suggested, a piece of hard buttered toast, a chop bone, a chicken drum stick, a strip of tough round steak long enough for the mother or nurse to keep hold of at one end will be of great developmental benefit at a time when a youngster wants to get everything in its mouth. Something hard should be introduced at each meal. If an infant is weaned from the breast or bottle to a sloppy diet he never will learn to chew his food. He will reject bread crusts, meat that is not tender and will not get a basal development adequate to support the larger permanent teeth.

More temporary arches are normal than permanent ones at least up to four or four and one-half years and there is little doubt in my mind that the trouble starts in most cases when the baby is weaned.

Now, what has all this to do with the advisability of extracting teeth as a way that is easiest on the orthodontist, the patient, and the pocketbook of the parent. Just this, to quote Spencer, "The highest aim in science is the perfection of man." Mutilation is a makeshift and some of the attendant ills which accompany it are the breaking of the continuity of the dental ligament, probable tipping of the teeth into the spaces with a strong prospect of establishing food pockets and pyorrhea or caries eventually, especially if it is done as a palliative measure to shorten the treatment. Cryer says speech is not as comfortable and often the tongue is crowded back so the patient is forced into mouth breathing. It is strikingly noticeable that most successful persons have well developed faces, the sinuses are adequate, the nose efficient, the dental arches well developed and the general physique is good.

When we extract, after all, we are nearly always only catering to the pride of appearance. Is the specialist warranted in treating cases where the capacity for appreciation is so limited? Are there not enough cases among the intelligent and appreciative who will, when they understand the full advantages of a normal development, manage perhaps even at great sacrifice, to have the work done. If we are specialists in anything more than name it is our duty to do our best to maintain the full complement of teeth, especially with those in the active growing period. There are plenty who just dabble in orthodontia to take those cases which an orthodontist of high aims cannot conscientiously assume.

We have our poor, too. If they are greatly handicapped there is a way to manage a few cases where there is little or no recompense, but they get the same quality of material, workmanship and treatment as those who are able to pay the fee. These cases have to be selected with care because cooperation and a desire to see the work through must be assured.

Dr. Badcock speaks of certain children where there is lack of cooperation either from the child or parents or where there is definite antagonism. We all get cases of this sort but the sooner they are dropped the better.

Missing teeth, peg teeth, etc., are mentioned as Nature's trend to accommodate herself to the newer and lesser demands for mastication. This theory is plausible but not scientific. It seems much more likely to be due to some atavistic tendency. We know, for instance, that in many cases of missing teeth there is a specific history.

Our knowledge of the ductless glands is, so far, very limited yet hypofunction of certain glands is associated with peg or missing laterals and it is known that thyroid extract will hasten the eruption of teeth and that this secretion has much to do with the quality of teeth.

Dr. Badcock has written his paper so well and has presented his points in such a telling manner that one is almost persuaded that he is right. Nevertheless, this paper, no matter how good his intentions, and I do not doubt for a moment the good intentions of the essayist, I believe to be an extremely harmful one. It gives the untrained, the incompetent, the unscrupulous and the lazy a chance to say that so eminent a person as Dr. Badcock, an honorary President of the International Orthodontic Congress, advocates the extraction of teeth as an easier and cheaper way of getting a permanent and satisfactory result. That the chances are if treatment is not begun with the temporary teeth (6 or 7 years) but delayed until most of the permanent teeth are in place the probability is that the result will not be permanently satisfactory.

We have a lot to learn about etiology. We have treated our cases much too long because of lack of this knowledge but I believe we *do* understand the successful treatment of certain cases and that we are adding to this number from time to time. Perfection may never be obtained but the next generation will be the better if we try to use the full equipment Nature gave and learn a few needed lessons in biology.

Dr. Harold Chapman, London.—Dr. Badcock, Mr. President, Ladies and Gentlemen.—I had the pleasure of a demonstration of the Merrill Palmer exhibit in the room over there yesterday from Dr. Lewis. One of the cases there was very marked, and I couldn't help thinking of it when Dr. Badcock referred to the necessity of considering health and physique of the children.

The particular case I have in mind had narrower arches by far than any case in that exhibit. That child had a very bad antenatal history. I am not quite certain, but it can be verified, that the child is also in poor physical condition. It seems to me that there is a serious underdevelopment of the jaws in the child, and that being so, I do not see how we can expect the jaws ever to catch up, especially when we remember that the rate of growth is becoming less every year.

The mandible increases, as we can see from Crile's book, about twice in size in the first year of life, and if the growth does not take place at the right time, if the deficiency is at all great, I do not believe we shall ever be able to absolutely catch it up. It would seem to me if those teeth are a normal size, as they appear to be, and if I am right in assuming that the jaws are very small, that is a case in which the extraction of permanent teeth later on is a very legitimate and proper course.

Dr. Maxwell Stephens, London.—Ladies and Gentlemen.—I feel called upon to speak on this occasion because I feel that as a general dentist, in fact in general surgery in London, one comes in contact with a great number of patients from all over the world, and that it is our duty to study every means of treating the malformations which we observe.

With regard to the patients, of which we are treating the second generation, mothers must be instructed to bring the children to us at the age of three, if not two, as I find that expansion with an ordinary Badcock plate, as we call it, at this time is very efficacious and convenient, for the children are able to carry on the work when they are away for long periods. The expansion very often is a ready means of reducing mesiodistal occlusions to normal position.

I think that what you are likely to overlook if you have not practiced in England and in London is the very large number of cases which come under our notice where there is a great contraction and lack of growth across the palate. You can have no conception of what we have to face. We make of the mechanics a god almost. It has got me in sitting here that that is a fact. I think also that it requires a bold man to come forward in this company and bring to your notice a paper such as Dr. Badcock has brought. But you must not forget what I have already said, that the conditions, which I do not think he stressed quite enough to you, are very different, and that we have such very narrow pinched arches to deal with.

There are many cases that have large teeth and small arches, and I have felt even at the early age of three that I should have to extract later on in spite of my expansion and stimualting growth and the use of muscle exercises. They simply will not expand, and you cannot get an esthetic appearance in a child with a short upper lip, big teeth, and a pinched face, whose parents are of a race that has a tendency to contract. The esthetic eye revolts from it. I have seen it, I have done it, and it is absolutely wrong. I have had to go back on my tracks and extract later on.

I have made all the excuses to myself that Dr. Crosby has made for years. I have adopted Angle's treatment, or rather his principles, and have to admit that they failed, and it is a great disappointment. As I say, one has to be bold to admit it, but the conditions with us are obviously different.

Dr. J. H. Badcock (closing).—I have to thank you ladies and gentlemen for the kindness with which you have received my paper. I expected that there would be little left of me to discuss it.

Dr. Crosby I must thank, too, for the way that he has dealt with the question. The difference between Dr. Crosby and myself is chiefly this, that Dr. Crosby believes there is only one right way. I believe that the way is right which is right for that particular patient.

I yield to no one in my admiration of the ideal, and I strive to attain it, but I am not always able to do so. I can hardly agree with Dr. Crosby that the fewer number of teeth which Nature is giving us now is atavistic in tendency because the normal mammalian dentition, as I would remind you, is forty-four.

I do not know that there is anything else to answer in the discussion, but in conclusion perhaps I may inquire with Bishop Barclay whether one whose end is to make his fellowmen think may not gain his end though they should not think as he does.

THE CORRECTION OF A UNILATERAL LINGUOVERSION OF THE MAXILLARY TEETH BY USE OF THE REMOVABLE LINGUAL APPLIANCE AND AUXILIARY SPRINGS*

By William E. Flesher, D.D.S., Oklahoma City, Okla.

PATIENT, a girl seven years old at the time treatment was started.
Type of malocclusion: A neutroclusion with a lingual relation of the deciduous cuspid and molars and the first permanent molar of the maxillary teeth on the right side of the dental arch.

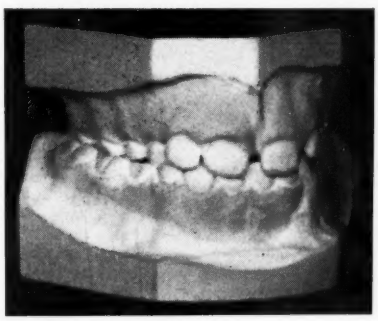

Fig. 1.

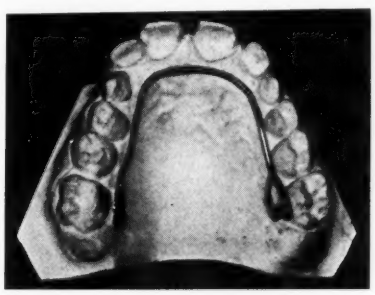

Fig. 2.

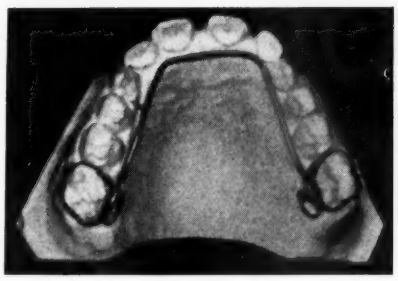

Fig. 3.

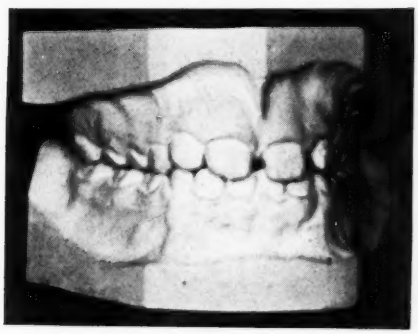

Fig. 4.

The mother states that the child has slept with the right side of her face on the pillow. There is a lack of development in the right maxillary region and the right side of the nares, as shown by the photograph (Fig. 5).

Fig. 1 shows the position of the teeth at the beginning of treatment.

Fig. 2 shows the appliance used to change the right maxillary molar from a lingual position to its typical cusp relation.

A horizontal tube was used on the right maxillary molar band so that the lateral stress on this tooth would cause it to tip buccally. The lingual arch wire on the right side was adjusted away from the deciduous molars

*Case report before the First International Orthodontic Congress, New York City, August 16-20, 1926.

and cuspid so it would not interfere with the buccal movement of the permanent molar.

A vertical half-round tube was used on the lingual of the left maxillary molar band into which a half-round pin on the lingual arch wire engaged. This gave a stabilized anchorage of this tooth. To reinforce this anchorage, the lingual arch wire was placed close to the deciduous teeth on the left.

When the mesiolingual cusp of the right maxillary first permanent molar came into occlusion with the central fossa of the right mandibular first permanent molar, the right maxillary molar band was removed and the round tube was unsoldered and a half-round tube placed thereon. A new lingual arch wire was then constructed with half-round pins to fit into the half-round tubes on both sides. The apices of the roots of the first permanent molar were then moved buccally until there was a typical cusp relationship with the mandibular molar. At this stage of treatment a reverse curve auxiliary spring was attached to the right side of the lingual arch wire.

Fig. 5.

By a gentle adjustment of this auxiliary spring once each month, the deciduous molars and cuspid were moved buccally, as shown in Figs. 3 and 4.

The first appliance was adjusted to the teeth February 11, 1925.

Impressions for the models as shown in Figs. 3 and 4 were made October 8, 1925.

On August 1, 1926, the development of the cuspid eminence indicated that the permanent cuspid would erupt into its typical relation with the mandibular teeth.

No appliance was used on the mandibular arch.

No labial appliance was used. Buccal tubes were placed on the maxillary molar bands for use of the labial arch wire, should reinforcement of the anchorage require it.

The appliance as shown in Fig. 3 is the one used on the patient.

REPORT OF CASES EMPHASIZING THE IMPORTANCE OF SECURING PROPER VERTICAL DEVELOPMENT IN THE MOLAR AND PREMOLAR REGION*

By B. Frank Gray, D.D.S., San Francisco, Calif.

THIS series of ten models, while exemplifying many phases of malocclusion of the teeth, is exhibited for the principal purpose of emphasizing the *vital importance* of paying adequate attention to the *lack of vertical development* in the molar and premolar region. It is my belief that this requirement is more often overlooked or temporized with than any other major factor in the *causation* and *perpetuation* of malocclusion of the teeth.

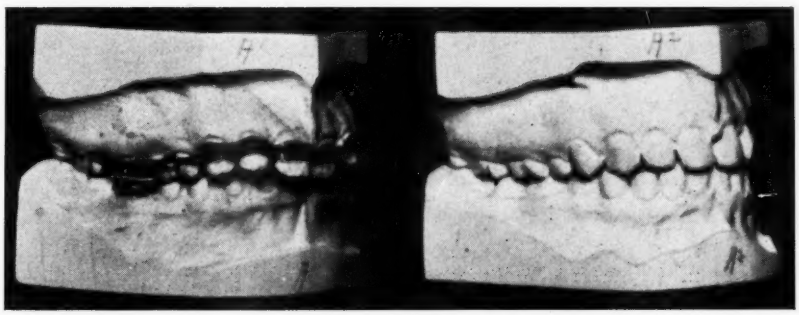

Fig. 1.

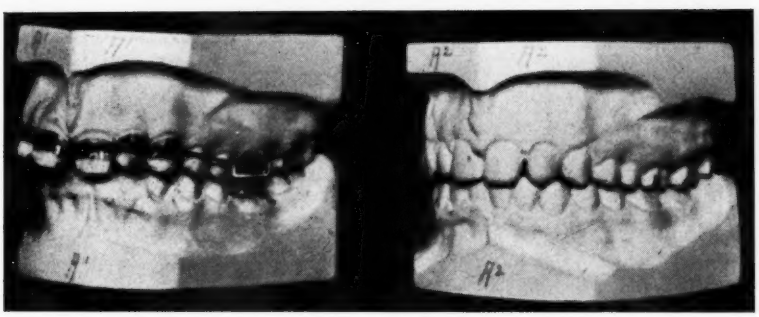

Fig. 2.

Figs. 1 and 2.—Case A^1 A^2. Age 19, Class II, Division II (Angle). Treatment commenced January, 1925, and brought to "retention" stage as noted March 1, 1926. Appliances: maxillary arch plain molar bands; bands on incisors and canines carrying open tubes as elaborated by Dr. James D. McCoy. In mandibular arch, inside arch wire attached to plain molar bands with Angle-Young locking device. Retention as in Case E.

While the principles involved in the treatment of the cases shown are not new and other methods are in daily use in my practice, it has been found, where many features of malocclusion other than the one I am now emphasizing must at the same time have attention, the correction as a whole is expedited through such procedures as were followed in the examples shown.

In each of these cases (A, B, C, D, E) where labial arch wires are used in the maxillary arch, their attachment to the anterior teeth afforded a

*Case report before the First International Orthodontic Congress, New York City, August 16-20, 1926.

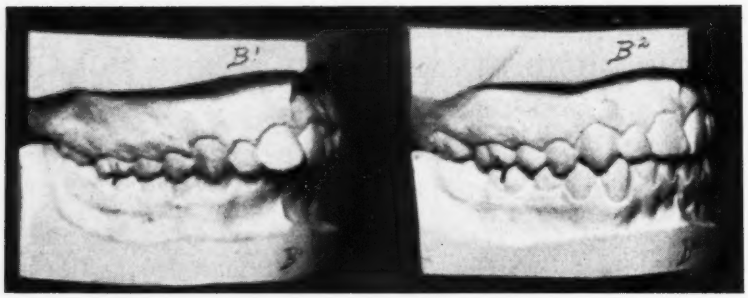

Fig. 3.

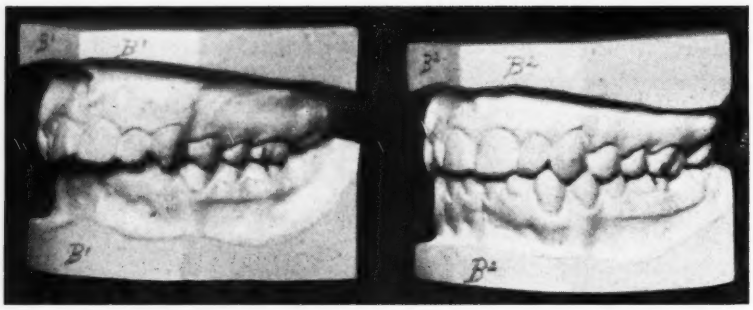

Fig. 4.

Figs. 3 and 4.—Case B^1 B^2. Class I (Angle) approximating Class II. September 11, 1922—March, 1924. Appliances: maxillary arch Angle ribbon arch and bracket bands, plain molar bands. Mandibular arch, inside arch wire attached to plain molar bands—Angle-Young locks. Age of patient, thirteen years. Retention as in Case E.

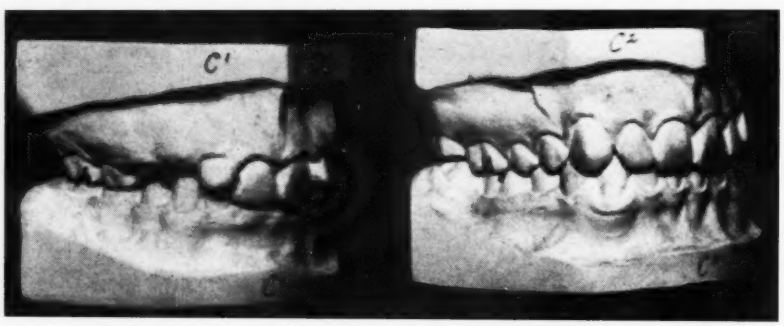

Fig. 5.

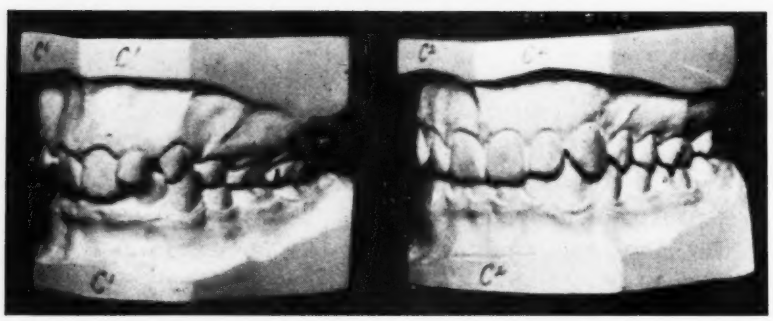

Fig. 6.

Figs. 5 and 6.—Case C^1 C^2. Age 13. Class II, Division II (Angle). July, 1918. Interrupted treatment periods. Appliances: Angle ribbon arch in maxillary and mandibular, plain molar bands; braket bands on anterior teeth. Retention as in Case E.

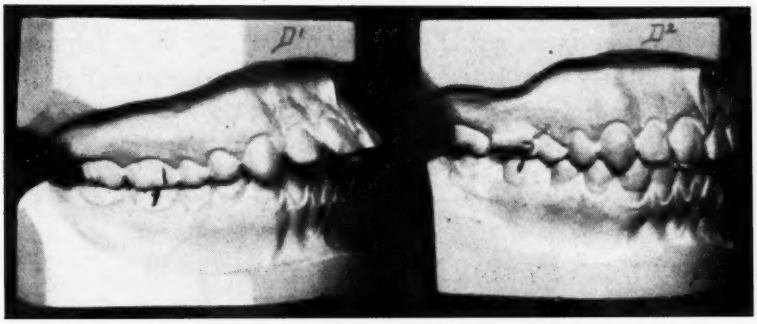

Fig. 7.

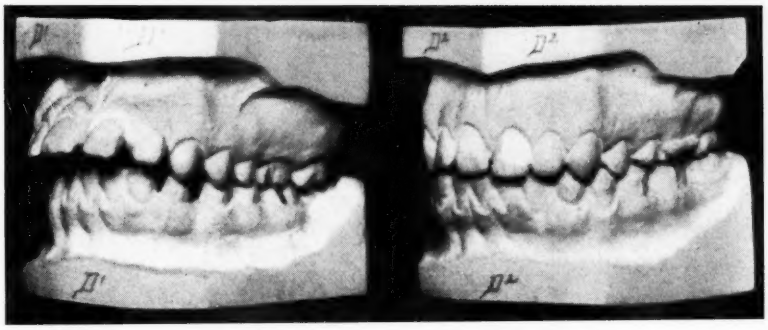

Fig. 8.

Figs. 7 and 8.—Case D^1 D^2. Age 18. Class II, Division I, Subdivision (Angle). March, 1922—May, 1924 (interrupted treatment). Appliances: maxillary, Angle ribbon arch and bracket bands (with modifications). Mandibular arch, similar appliances. The left mandibular canine defied every method of rotation known to the operator. Retention as in Case E.

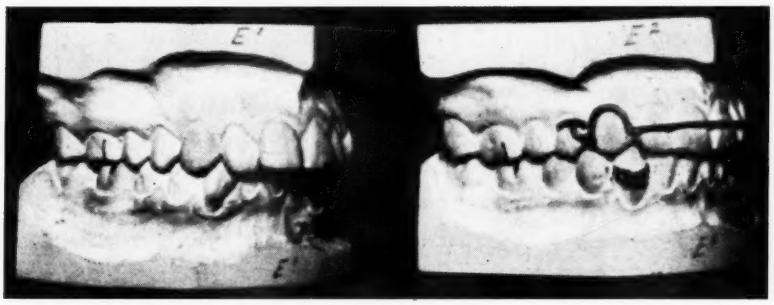

Fig. 9.

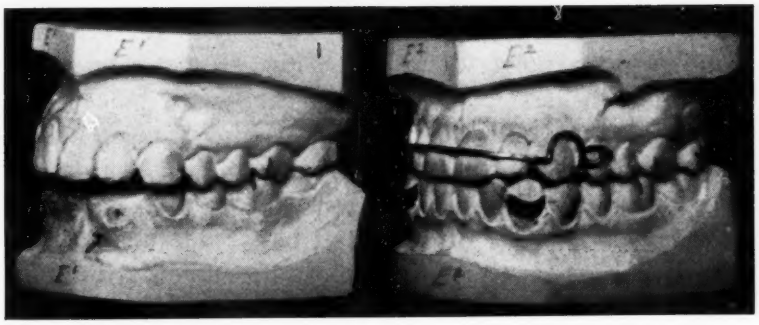

Fig. 10.

Figs. 9, 10 and 11.—Case E^1 E^2. Class I (Angle). November, 1919—May, 1921. Appliances: maxillary arch Angle ribbon arch attached to plain molar bands. Mandibular arch, ribbon arch for a portion of the time, then inside arch wire attached to plain molar bands—Angle-Young locking device. Age of patient eighteen years. *The general plan of "Retention" used in this case was followed in cases A, B, C, and D.*

fulcrum whereby the upward spring of the arch, when locked in position, resulted in elongation (vertical development) of the first permanent molars of that arch. Similarly the anterior teeth of the mandibular arch afforded a *fulcrum* whereby the downward spring of the arch wire (be it inside or outside) effected the vertical development of the first permanent molars of that

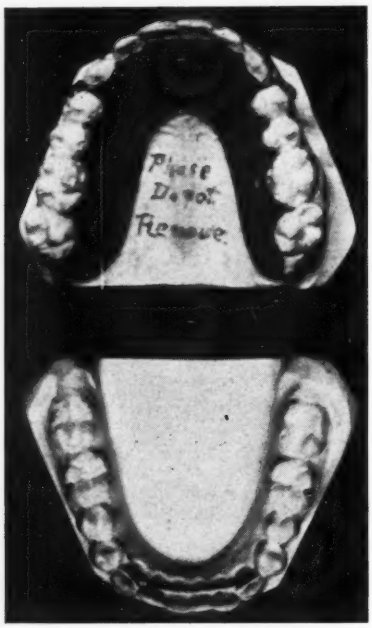

Fig. 11.

arch. The vertical development of the premolars and of the second permanent molars follows without orthodontic aid other than adequate retention of the case.

The retention of each case in the series is illustrated in Case E.

OCCLUSAL RESTS*

By Jesse F. Keeney, D.D.S., Quincy, Ill.

IN THOSE cases in which an occlusal rest is needed, for the support of the appliance at a given point, make a plaster or compound impression of the tooth for which the rest is needed; pour up with loheet No. 1; let set and dry; separate, and wax up the rest with casting wax as it is to be in the cast; invest; heat up and cast, using hard gold; trim, polish and place on the model in desired position and solder to appliance.

These cast rests are much stronger and better adapted to the tooth than any I have ever seen; the limit of their usefulness is only limited by the one using it. They may be cast either single or multiple as is desired for the case in question.

*Clinic before the First International Orthodontic Congress, New York City, August 16-20, 1926.

REINFORCED BANDS*

By Jesse F. Keeney, D.D.S., Quincy, Ill.

SELECT the tooth to be used for a band; take impression in plaster or compound; pour it up in loheet No. 1; trim the interproximal surface and at the gingival edge around the tooth, in the natural contour of the tooth; then take a piece of band material and fit it into the interproximal space, mesial and distal, contour to the gingival and occlusal margins; lay aside for a minute, then wax up the buccal and lingual aspect of the tooth with casting wax, and fit band to the gingival as well as to the occlusal contour of the tooth.

The pieces of the band material that were laid aside are heated slightly, starting with the mesial, and pressed into place; the slight overlap on the buccal and lingual surface of this band material will, if properly heated, melt the wax sufficiently to give a good union of the two parts, and the heated material will immediately go to the proper place. This process is repeated with the distal, and if due care has been taken, a good foundation for a strong reinforced band is formed.

The model is then trimmed, the spur wires attached and invested. After allowing the model to dry, it is heated, as for any form of casting, and cast with either 22-K gold or hard gold as desired. At the union of the cast and band material, I sometimes use a minute piece of 18-K solder to make sure of the union; then trim, polish, etc.

The making of this band requires time, but its strength and fit overcome this objection. If a bite plane is required on either the mesial or distal, it can be added very easily at the time of waxing and thus cast in one piece with the band.

I believe these are the strongest and best fitting bands used today. I do not use them in all cases, but for the past four years I have used them in cases where I was afraid of edge strength or wished a strong band for reinforcement, and they have proved satisfactory.

*Clinic before the First International Orthodontic Congress, New York City, August 16-20, 1926.

ABNORMALLY ATTACHED FRENUM LABIUM WITH SURGICAL INTERFERENCE*

By E. W. Patton, D.D.S., Birmingham, Ala.

SPACING seen between upper central incisors and sometimes, though seldom, between lower incisors is often caused by the overdeveloped and abnormally attached frenum labium. Space varies in width and affects speech in direct proportion to its size.

At birth this organ is attached at the gingivus or gum border, but when normal and in the mouths of patients whose permanent incisors have erupted its attachment is about five millimeters above this point. When the frenum is abnormal as to size and attachment its fibers pass through between the incisors, attaching ofttimes in a deep fissure formed by the maxillary bones, and ending in a tuft of tissue lingual to the gingival border of the gums. Upon raising the upper lip the frenum will be seen to spread out in fan-shape, losing the end of its fibers in the lip. This fact makes it a most potent factor in separating the incisors, and ofttimes lifts the whole of the anterior portion of the mouth, causing a protrusion, since each movement of the lip produces a pull on the tissues to which the frenum is attached and which it touches. It might well be compared to a bundle of rubber bands lying between the central incisors and capable of constant expansion.

The clinician recommends that orthodontic treatment be commenced, and under gentle stimulation the space between the incisors be partially closed. When two-thirds closed, the frenum should be removed surgically.

This operation is performed by anesthetizing the tissues, and with sharp and keen bistoury, cutting down to the bone on each distal margin of the frenum and around the tuft of tissue on the lingual, thus enucleating the organ. Then with sharp small currette or spoon excavator the whole organ is peeled out from lingual to labial and from deep down in the fissure. With sharp knife or scissors it is then cut off about five millimeters above the gingival border. A few sutures may be taken, but the clinician rarely finds this necessary. Teeth should now be moved into contact with each other, and retained there until fibers from each adjoining wall have united, and tissues have become fixed in their new environment.

*Clinic before the First International Orthodontic Congress, New York City, August 16-20, 1926.

ABSTRACT OF CURRENT LITERATURE

Covering Such Subjects as

ORTHODONTIA — ORAL SURGERY — SURGICAL ORTHODONTIA — DENTAL RADIOGRAPHY

It is the purpose of this JOURNAL to review so far as possible the most important literature as it appears in English and Foreign periodicals and to present it in abstract form. Authors are requested to send abstracts or reprints of their papers to the publishers.

Loss of Oral Function. L. Bosworth (San Diego). The Pacific Dental Gazette, September, 1926, xxxiv, 9.

The author discusses the moot question of the relation between dental pathology and lack of proper employment of organs. Free use in mastication among primitive peoples wore down the teeth rapidly so that, while as a rule they escaped caries as a malady of the relatively young, they developed root infection and pyorrhea. Among the more civilized among the ancients there was a good deal of caries as well. Impaction came first in frequency among the old Egyptians and was followed by attrition, caries, root infection, and periodontia in the order of frequency named. Among primitives occlusion is better than in civilized man. The factors which produce malocclusion and maldevelopment of the jaws and teeth in general differ with the viewpoint of the scientist. Janney accuses the endocrine system as the basic factor. The average dentist believes that proper mastication will secure proper development of the jaws and teeth and that if this function is slighted these structures must suffer, thus disregarding the endocrine influence. The author cites this view as illustrative of the backwardness of the average dentist in scientific knowledge. In the author's opinion excessive mastication can only develop the masticatory muscles but cannot prevent malocclusion or dental disease. That there is a racial tendency to disproportion between the teeth and jaws is not proved although we see individuals whose teeth may seem too large or too numerous for the accompanying jaws. These mouths can be corrected by the orthodontist by his various resources. The author is not in favor of extracting well functioning third molars. The burden of the article appears to be that there are no disabilities of the teeth which the dentist cannot remedy. That is what he is for.

Subsidence of the Extraction Mania. Editorial in the Dental Cosmos, September, 1926, lxviii, 9.

The editor expresses his satisfaction at the unmistakable tendency against indiscriminate and ruthless extraction in the attitude of the medical profession who no longer recommend this practice as a cure-all for all serious body (and he might add mental) ailments. The editor of the *Dental Cosmos* has never wavered from a conservative course although many dentists have been

obsessed by the attitude of the medical man. These wrongly demanded extraction when what they should have sought was sterilization, which may often be obtained by less radical methods than exodontia. No one doubts the possible menace of infected teeth, but extraction may mean a certain loss against a problematic gain. We continue to learn in the field of oral sepsis and one of the most recent additions to our knowledge is that an infection about a tooth may itself be a result of disease elsewhere in place of a primary lesion. If the tooth is pulled, the original focus still holds the menace. A certain faction of the dentists has shared the medical opinion not so much from conviction as because they dread the labor and possible technical failure of root filling. Conservative surgery in dentistry is as much indicated as in surgery proper. Total ablation of the ovaries, for example, gave way to puncture and resection. Complete enucleation of the eye was succeeded by leaving a stump with muscular insertions, in the interest of cosmetic effect in connection with glass eye prosthesis; and amputations of limbs are also made with reference to the most useful prosthesis. In operating conservatively on infected teeth the principle is much the same, although the element of sepsis may at times demand radical removal of the focus.

Amalgam Fillings and Mercurial Poisoning. C. F. Boedecker (New York). Dental Items of Interest, September, 1926, xlviii, 9.

The author comments on the rather sensational article by Professor Stock which appeared in a German chemical journal and caused much discussion among the German dentists. The supposed poisoning differs from ordinary mercurial intoxication in that it does not involve salivation and ulceration in the mouth, but consists merely in enervation, or neurasthenia, including weakening of the memory. Professor Stock noticed this peculiar form of poisoning in himself after having been working with mercurials. At first he complained only of loss of energy, inability to do hard mental work and failure of memory but later not only did ordinary mercurial poisoning develop but all others who had been exposed were found to present symptoms. Analysis of the room air showed but a minute amount of mercury vapor in suspension. Chancing to experiment with amalgam-filled teeth he found that at a temperature of 30° C. these gave off vapor to the air, irrespective of the age of the filling. In regard to actual poisoning from fillings, one case is given in which the only symptom was a headache which subsided after the extraction of an amalgam-filled tooth—hardly enough to serve for sweeping charges against the metal. Leaders of the dental profession in Germany have not taken the allegation seriously, nor does Dr. Boedecker, although the latter thinks it well to use all precautions in amalgam filling by thorough condensation and by removal of excess mercury.

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EDITORIALS

The New York Society of Orthodontists

THE fall meeting of the New York Society of Orthodontists was held at the Hotel Vanderbilt, Oct. 27, 1926. The meeting opened with the usual business session.

As a part of the scientific program Dr. Leuman M. Waugh, of New York City, presented two patients showing arches with anterior sections of 0.022 round wire fitted into Angle bracket bands. Dr. J. Lowe Young presented two patients showing pin and tube appliances in position. The presentations demonstrated very nicely the use of the appliances in question, but still left a doubt in the minds of many as to the advisability of these appliances in comparison with other devices which produce a more physiologic development. There seems to be a tendency toward the use of appliances which allow teeth to respond to the functions of mastication more readily than is possible either with the bracket bands or the pin and tube appliances. In

referring to the desirability of having a small amount of pressure exerted upon malposed teeth and having those malposed teeth so attached as to be free to respond to mastication, we need only mention the next paper on the program by Dr. Russell E. Irish, of Pittsburgh, under the title of "Conscious, Constructive Application of Pressure." It seems to us that Dr. Irish's presentation, giving an entirely different type of pressure than that shown by either Dr. Waugh or Dr. Young, might be considered a discussion of relative value between the types of appliances mentioned. Dr. Irish has designed an instrument for measuring the amount of force exerted by delicate finger springs. He also showed the amount of force exerted by a labial alignment wire, which appliances may be considered the basis of the ribbon arch and the pin and tube apparatus. The amount of force exerted on the labial alignment wire with a small adjustment of the nut at the distal end was greater than the force exerted by delicate finger springs. In summing up the information which he had obtained, Dr. Irish stated that the smallest amount of pressure necessary to produce cell metabolism is the amount which should be used in the correction of malocclusion. The smallest percentage of pressure beyond that required to produce cell metabolism was, from a physiologic standpoint, too much pressure. From the discussions which followed Dr. Irish's paper, it was very evident that some men have never mastered the purpose or technic of a finger spring. A statement was made that finger springs when exerting pressure on anterior teeth invariably intruded or shortened the incisors. The discusser stated that an incisor could be intruded much more easily than it could be moved labially, which is contrary to the clinic evidences found in the practice of many men. It has been our experience that intrusion or depression of the teeth is the most difficult movement of all to produce. The careful analysis and study of the supporting structures of the teeth well demonstrated that the peridental membrane and the alveolar process are arranged to stand the strains of mastication and to prevent the teeth from being depressed in their socket. The construction of the fibers of the peridental membrane is such as to prevent an intrusion of the teeth or a depression of the teeth and no evidence has ever been presented other than the mere statement, without proof, that incisors are ever depressed from the pressure of finger springs. Furthermore, with the proper use of recurved finger springs there is not the slightest tendency to either depress the incisor or to elongate the incisor. In any cases treated with recurved finger springs where there has seemingly been a depression of the incisors, a careful analysis will invariably show that the anchor teeth have elongated. This elongation of the anchor teeth is also the result of improper technic. Dr. Irish's paper was one of the most scientific analyses of the application of pressure from finger springs that has ever been made. A great many points which he demonstrated were not appreciated by the majority of the audience because of their unfamiliarity of various types of finger springs and pressure exerted from different sized wires. In the discussion of the paper, Dr. Frederick L. Stanton stated that Dr. Irish had demonstrated one of the laws known by engineers which can be stated briefly, "that when we double the size of a wire or beam we increase the potential strength of the wire or beam by four." Consequently, Dr. Irish's demonstration showed that the

amount of exertion produced by 0.025 wire was nearly twice as much as that exerted by 0.020 wire. These facts had been realized by some men prior to Dr. Irish's presentation but should be given more consideration in the construction of appliances than they have had in the past.

Dr. Milo Hellman gave a preliminary study in the development of the human face. By careful measurements he showed that the face developed in different regions more rapidly than in others and also more rapidly in patients of different ages. It was one of the most scientific analyses of the development of the face we have ever listened to and can only be appreciated by a careful study of the measurements and tables which he showed. Dr. Stanton reported a case of identical twins, showing similarity by interrelated maps. This demonstrated the close similarity in the two types of malocclusion and also showed the accuracy with which each arch had been determined prior to treatment. The maps of these patients, which were made separately without any reference of one to the other, were later interrelated, and demonstrated the similarity of not only the malocclusion but of the predetermination.

Dr. C. A. Hawley, of Washington, D. C., made some comments on the literary program of the First International Orthodontic Congress. These comments were virtually the reaction some of the papers had upon Dr. Hawley, chairman of the program committee, who in that capacity had edited the papers before they were sent to the publishers. He also stated that 80 per cent of the literary program of the First International Congress had been sent to the publishers of "The Transactions" and gave Nov. 1 as the limit for the receiving of mail for publication.

We hope that we will be able to give our readers a complete transaction of the program of the New York Society of Orthodontists as soon as same is received from the board of censors for publication.

Chapman Article—Orthodontics: Retention

IN THE September issue of this Journal appears an excellent paper by Dr. Harold Chapman entitled: *Orthodontics: Retention.* This paper is the result of careful study on the part of the essayist. We are fully in accord with many facts that are presented. There are, however, some presentations of facts which we believe could be clarified by a little different interpretation.

In times past, correction of a case of malocclusion was divided into treatment and retention. Treatments were supposed to consist of application of force on malposed teeth for the purpose of causing them to assume proper position in the line of occlusion. After the teeth had been moved to the so-called normal position, the period of treatment was supposed to end and the retention was begun. Such retention consisted of the application of force to overcome the backward tendency of the teeth. The real purpose of retention as understood in modern orthodontics is to hold the teeth in the new position until such a time as the force of occlusion can be established. It is very readily recognized that the mere act of holding teeth in the new position regardless of how long they were held would never insure a perma-

nency of results. As a result of this, retention is divided into natural and mechanical. Natural retention is the result of force of occlusion which includes normal cell metabolism, muscular pressure, atmospheric pressure, force of occlusal surfaces, force of approximal contact, harmony in the size of the arches. All of these natural forces must be present if the teeth are going to maintain a normal position in the dental arch as related to the face and cranium. Mechanical retention consists of the use of some mechanical device until such a time as all the natural forces of retention can be established. It was also early recognized that mechanical retention could be divided into active and passive retention. Active retention is that type whereby the mechanical device is so constructed that a gentle mechanical force would be exerted to overcome the backward tendency of the teeth. Passive retention consisted of so constructing a mechanical device that no active force would be exerted by the appliance and act as a means of preventing the return of the malposed teeth to the old position. We have clinical proof that more satisfactory results can be obtained by using active mechanical retainers. As a result of this it was found that active mechanical retainers could be placed very early in the treatment of conditions. At the present time a great many cases are carried to completion without ever having a so-called retaining appliance in the mouth. The reason for this is that the regulating appliances have been made so delicate that they compare very favorably with, and sometimes are less bulky than, former retention appliances. Therefore, with the perfection of orthodontic methods, retention has ceased to be a phase in the treatment of a great many cases of malocclusion. The entire case from beginning to end is treated with the appliance so constructed as to assist the natural forces of retention. Therefore, when all the forces of occlusion are working normally there is no need of the mechanical retaining device.

One of the most persistent questions asked by patients and students is how long malposed teeth should be retained to insure their permanency. The question of retention cannot be answered on a time basis because time is one element which has very little to do with the permanency of results. If the teeth do not occupy their proper position in the dental arch and all the forces of occlusion do not function properly, mechanical retention will be necessary during the entire life time of the individual. In other words, you cannot insure permanency of position by prolonging the mechanical retention when the forces of occlusion are abnormal. Dr. Chapman has featured the importance of the teeth performing their normal function during the period of retention, but it must be remembered that normal function of the teeth should exist during the entire treatment of the malocclusion. If a regulating appliance is so constructed as to allow all of the forces of occlusion to act normally during the time the teeth are assuming normal positions in the dental arches, retention is unnecessary.

It is our belief that more orthodontic failures have resulted because practitioners have pinned their faith to the old supposition that prolonging mechanical retention would insure permanency of results, than from any other factor. We have seen patients wearing certain types of retainers when in reality the malocclusion should still be undergoing active treatment. Re-

tention had been instigated before the teeth were so placed as to allow all the forces of occlusion to function properly. These cases show a decided improvement from the original condition at the time the retaining appliances are placed but unless the so-called retaining appliance is an active mechanical device the case will invariably be a failure. We know of a great many men who have placed a certain type of retaining device before the treatment was completed. The patients are wearing these retainers believing that if they wear them long enough permanent results will be obtained. Owing to the fact that all the forces of occlusion are not functioning, such cases as I have mentioned will end in failures. If the treatment had been continued to a point where all the forces of occlusion were normal, the case would have been a success. Having seen this condition so often we have practically discarded the use of mechanical retention and never discontinue active treatment until all the forces of occlusion are established and then no retaining appliance is necessary.

During the past few years orthodontic literature has contained many papers on muscle exercise and muscle training. From the large number of papers written, younger men might believe that muscle training and muscle exercise are new factors in orthodontic treatment. As a matter of fact, the importance of muscle exercise was recognized by Dr. Angle in his early teachings, yet some of his former students seem to think they have made a wonderful discovery; but what is true in regard to muscle exercise has been long known, and what is new is not true. One of the most misleading ideas in regard to the value of muscle exercise in retention is the often repeated benefit that is supposed to come from the action of the external pterygoid muscles and the masseter and temporal. Patients are placed on exercises which consist of having them exercise the external pterygoid muscle for the purpose of moving the mandible forward. The statement is made that if this muscle is strengthened sufficiently by these exercises, it will hold the mandible forward. Some men have gone so far as to contend that the action of the external pterygoid, as I have described, will correct posterior occlusions. An analysis of the origin and insertion of this muscle and its normal function would clearly show that the external pterygoid has absolutely nothing to do with holding the mandible forward. No bone is held in position by muscular action. The ligaments of the joints are the only structures which hold bones in position. The exercise of the temporal and masseter, provided the cusps have a normal relation, will be beneficial because it will create a blood supply to the parts and produce physiologic development. The proper action of the muscles of expression, respiration, and deglutition are essential. If these muscles do not function properly, mechanical retention will be a life long necessity. If they do function properly no mechanical retention will be necessary after correcting those cases of malocclusion in which abnormal muscular action was an etiologic factor.

Another misleading idea in regard to retention is that teeth are held in normal position by the development of the bone. Bone is a result of physiologic function and is a constant changing structure. As a result of these constant changes in order for bone to develop normally, it must be subjected to stimulating influences of such a nature as to create the proper develop-

ment. The statement has often been made that bone develops as a result of mechanical stimulation and, from a biologic standpoint, I do not know as any one has attempted to disprove the above-mentioned statement. Orthopedic surgery is possible because bone does develop as a result of mechanical stimulation. However, if the mechanical stimulation is at variance with normal function, we find the spiculum of bone will be arranged to meet the demands of mechanical stimulation and will be arranged adversely to the normal forces of occlusion. Therefore, when the mechanical appliance is removed and the tooth is subjected to the force of occlusion, the bone must necessarily be rebuilt in response to the forces of occlusion. It is true that cases of malocclusion relapse unless the regulating appliance or the so-called retaining appliance has been so constructed that the forces of occlusion predominate over the forces exerted by the appliance. It also has been stated that teeth move during function and this movement is made possible by arrangement of the fibers of the peridental membrane plus a certain amount of elasticity which is found in the bone itself. Another factor which has a bearing upon the development of bone under the influence of function as compared to mechanical apparatuses, is found in the modern treatment of fractures. This treatment may be termed "movable fixation" in which the fracture is treated with the idea of allowing the parts to function as near normally as possible. The use of the parts is encouraged at an early period which is contrary to the old idea when a splint was worn for weeks and months, and the surgeon was sometimes afraid to remove it.

While retention may be considered as necessary in certain cases, it is our belief that the orthodontist should not pin his faith upon mechanical retaining devices which are not in harmony with histologic development and physiologic function.

ORTHODONTIC NEWS AND NOTES

The American Society of Orthodontists

The next meeting of the American Society of Orthodontists will be held in Chicago, May 3, 4, 5 and 6. A splendid program is assured. All ethical members of the American Dental Association will be cordially welcome. For further information address—Charles R. Baker, Secretary-Treasurer, 708 Church Street, Evanston, Illinois.

Chicago Dental Society—Important Notice to Out of Town Dentists

For dentists outside the city of Chicago who expect to attend the big meeting of the Chicago Dental Society, January 26, 27, and 28, 1927, at the Drake Hotel, Chicago, please read this notice carefully and make a memorandum of it at once for yourself.

A one and one-half railroad fare has been secured for you providing two hundred and fifty or more follow the instructions, and you can help in the following manner:

1. Be sure that when purchasing your ticket you request and insist on your agent giving you a certificate. Do not make the mistake of asking for a receipt, that will not answer, and be sure to be at the station at least thirty minutes before train time so that your agent has time to arrange your certificate.

2. Certificates are not kept at all stations, hence if you inquire of your home station agent and find he does not sell through tickets and certificates, he can tell you the nearest station, and on your way, where you can secure your ticket and certificate, and you purchase a local ticket to this station and from this station to Chicago (one way) and certificate. No refund of fare will be granted upon your failure to get a certificate.

3. Immediately upon your arrival at the meeting, turn in your railroad certificate to the Transportation Committee at their booth in the lobby of the Drake Hotel for endorsement and validation. Do not fail to do this—your part.

Frank W. Booth, Chairman,
Transportation Committee,
Chicago Dental Society.

The Mid-Winter Meeting of the New York Society of Orthodontists

The mid-winter meeting of the New York Society of Orthodontists will be held December 8, 1926, at the Vanderbilt Hotel, 34th St. and Park Ave., New York City. Both practical and scientific material of real value will be presented. Those who are interested in the growth and progress of this specialty cannot afford to miss this meeting.

Notes of Interest

Dr. Percy Norman Williams has announced his retirement from active practice and that he will be succeeded by Dr. Stanley Milton Dow of Brooklyn, who will continue the practice at the same address, 40 East 41st Street, New York City.

Dr. D. Willard Flint has announced that his son, Dr. Wilson R. Flint, is now associated with him in the practice of orthodontia at 5113-5116 Jenkins Arcade, Pittsburgh, Pa.

Dr. Rolof B. Stanley will conduct his practice at 5 Popham Road, Scarsdale, N. Y., on Tuesdays and Thursdays from 1 to 5 P.M., and at 8 East 54th Street, New York City, on Mondays, Wednesdays, and Fridays from 9 A.M. to 4:30 P.M. and on Saturdays from 9 A.M. to 12:30 P.M.

Dr. George B. Scott has moved his office to 1213-1214 Missouri Building, St. Louis, Mo.

Dr. L. F. Pogue has moved his office to Suite 1012-1013 Bennie-Dillon Building, Nashville, Tenn.

Dr. John Oppie McCall has moved his office to 121 East 60th Street, New York City.

Dr. Louis M. James, Jr., has moved his office from 105 Hunter Avenue to 512 Argyle Building, 12th and McGee Streets, Kansas City, Mo.

Louis S. Winston, A.B., D.D.S., Houston, Texas, has moved his office from 707 Scanlan Building to 1216-17 Medical Arts Building.